



FACULTY OF TECHNOLOGY

# **Visual Project Management Practices to Control Projects**

Md Irfan Uzzaman

M.SC in Product Management  
Master's thesis  
March 2019



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# ABSTRACT FOR THESIS

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<p><b>Abstract</b></p> <p>In today's technologically advanced world, projects are becoming much more complex and managers often face challenges of controlling the pace of the project. Visual project management is a fundamental element of lean methods that allows the project management activities to accomplish efficiently and effectively within the timeline. The challenges and complexity of projects are on the rise nowadays due to distinct unpredicted characteristics for instance workplace accidents, environmental effects, price hiking of materials cost and so on. Lack of controlling and monitoring the external or internal events within the project sometimes drive to project failure. This thesis aims to gain an insight into the visual project management practices in various projects through literature analysis along with the understanding of the contribution of visual tools and elements in the purpose of controlling the project. The initial part of this research focuses on in-depth literature review concerning the functions, tools, elements and the current state of the visual project management. The analysis is conducted by keeping two case studies as examples. The literature review reveals the contribution of visual management to support managerial strategy by integrating information, providing the elements, tools, and sensory aids into various project work settings. Following this, a qualitative analysis of two case projects provides the insight into the findings of this thesis which focuses on the prominence of visual management in two different project characteristics. Through the analysis and discussion, the anticipation of visual management was explored and identify the findings that disagree or complements the previous literature. Nevertheless, the overall research is concerned with the improvement of the project performance and effectiveness, removing potential threats and uncertainties and controlling the project through visual project management philosophies.</p>			
<p><b>Additional Information</b></p> <p>Keywords: Visual project management, visual tools, visual elements, project control</p>			

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# 1. INTRODUCTION

This chapter introduce the background of this research, along with the objectives, research questions, research scope and structure.

## 1.1 Background of the study

In the recent competitive era, visual project management is an emerging concept which incorporates various visual tools and visualization data methodologies in addition to more conventional project communication, explanation, and facilitation practices. Moreover, companies are now seeking to improve their competences and want to eliminate the non-value-added activities from projects that hinder the simultaneous flow of the ongoing project. Visual project management is a revolutionary and evolving new approach, which leverages the introduction of the advanced technique of presenting the data, and information. Visual project management considers as a foundation to constitute lean principals within the project (Chapman, 2005). Moreover, the visually rich environment enhance the acquaintance and better understanding of the critical performance metrics and information of data points regarding the projects.

Project management nowadays can be ascertained as an extremely "data rich" business activity where the practitioners are capable of capturing, transforming and communicating hundreds of individual project data points. These data contain valuable information of the project, for instance, labor estimation, operational expenses, performance metrics, cost-benefit analysis and numerous numbers of project-related artifacts. The emergence of visual project management is based on the time compressed and lean business culture where the key project stakeholders do not have time to digest a verbose report of project status or maintaining a double-booked calendar for the upcoming schedules and meetings. Project decision makers intend to make a decision based on the ongoing situation and progress status. This inevitability of facts facilitates the creation of a new concept of "visual project management". According to Williams (2015), in terms of developing the project communication and collaboration and in addition to envisioning the process and workflow of the projects, visual project management is considered one of the best methods for leading as well as effectively managing projects. Moreover, Galsworth (2005) abridged that the term adopted of visual

management is compatible with multiple management of operations like different settings of manufacturing, construction or healthcare organization. However, apart from the lean manufacturing philosophies, the success of visual management is generally connected with process improvement concept that is many organizations' area of concern nowadays (Holweg, 2007). The latest customized approaches that create attraction in project management community today is a concept of presenting project-related information visually, often graphically, improvement of clarity, visibility and understanding the application of the operation. Nevertheless, the existing literature concern more about utilizing visual practices within manufacturing environment, however, for the further analysis within project context, raise some research questions that allude in the next section. Thus, the introduction of visual project management delivers information in such a way that the project stakeholders can consume it at a time, place and manner that is adjacent to them.

## **1.2 Research objective and questions**

The purpose of this research is to explore the utilization of visual project management practices in diverse organizations and projects set, which facilitates the improvement of project efficiency by eliminating non-value-added activities through providing the predetermined information of project status and data-rich environment for better decision-making, real-time issue management, and resolution status.

In order to conduct this research, the following research questions will frame the research's approach:

- RQ1. What are the impacts of visual project management practices in projects?
- RQ2. What are the practical tools and elements utilized in the context of the projects?

The first research question focuses on the consequences of visual project management methods in different projects. Besides, it distinguishes the attributes of visual project management that supports the managerial strategy to maintain and follow-up the project. As a part of lean methods, visual management contains several approaches and functions that lead towards control of the project and sustainable project goals. Finally, the second

research question emphasizes the participation of practical visual elements and tools in several project context.

### **1.3 Research structure**

This research study focuses on the visual management implementation in diverse projects and investigation of its impact on overall project control and improvement. Through the empirical study associated with case analysis, it can be depicted that visual project management plays a significant role in project improvement. Moreover, this study describes the utilization of various visual management tools and elements which mitigate the non-value-added activities and promote the improvement of the project drastically. It is always notable that, the implementation of visual management enables the empowerment to make decisions without oversight quickly. However, relying on the characteristics of the project, visual practices can be exploited. Finally, through analysis and discussion, the outcomes of visual project management are explored and potential further research areas are suggested which will result in the control of the overall project more fruitfully. Nevertheless, the overall research is described in the following chapters:

## Chapter 1 Introduction

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- Research background
- Research need, objectives, questions
- Research scope & structure

## Chapter 2 Literature Review

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- Visual management
- Visual management tools for project management
- Current state of visual project management

## Chapter 3 Research Design

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- Research methodology
- Research process

## Chapter 4 Empirical Analysis

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- Case description
- Analysis the contribution of VM in project
- Empirical analysis from data and interview

## Chapter 5 Results

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- Previous literature and current outcome analysis
- Answering research questions

## Chapter 6 Conclusion

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- Summary of the research
- Research limitations
- Future research scope

Figure 1: Research structure

## **2. LITERATURE REVIEW**

### **2.1 Visual management**

Visual management has been defined in various ways within the literature. It can be described as a management strategy for organizational control and improvement of communication to increase organizational efficiency (Tezel et al., 2015). In the present organizational era, Visual Management is considered as a management system which vindicates to improve the performance of any organization through consolidating and aligning of the organizational goals, vision, values, and culture. According to Liff and Posey (2004), visual management usually connects other management systems, workplace elements, work processes and stakeholders through anticipation, which finally addresses one or more of the five human senses (sight, hearing, feeling, smell and taste). Bell and Davison (2013) broadly defined the concept of "Visual" as a powerful in cognition and memory as compared to textual and verbal. Moreover, visual has also taken the prevalence in the daily mode of communication and management. Besides, visual as a form of pictures, graphs, film, web pages, and architecture converts the management research towards a counterweight to the linguistic form where language constitutes the meaning and reality. Over the last few decades conveying the information over the long distances have been tremendously improved, thanks to fast developing technologies for contributing to solving this problem. Recently, most of the organizations are confronting a typical scenario which is how to ameliorate their ineffective delivery of information to their workforces through the close range communication (Bilalis et al., 2002).

The idea of visual standards and instructions was first initiated and deployed at the Toyota production system in the 1950s and 1960s through utilizing a few popular visual tools (Ohno, 1988; Fujimoto, 1999). The concept of the sort, shine, set-in-order, sustain and standardize (5S) (Gapp et al., 2008) and the Poka-yoke (mistake-proofing) (Shingo, 1986) was promoted parallel at the same period. Visual practices are the foundation of many other lean principles (Chapman, 2005). In terms of manufacturing and production perspective, visual management tools deliver significant effort, without any clarification of their background. Visual management constitutes the building blocks of other lean tools (Chapman, 2005). With the rise of Japanese automotive dominance and enhancement on quality, Toyota Production System emphasizes utilizing VM in their

different production related projects (Shingo, 1989; Monden, 1998). The term that is used most frequently is visual controls which aim to achieve any specific task presented in a relatively easy-to-see and straightforward manner. However, the concept of visual control is not confined in any fixed dimension. The anticipation of several visual management tools and elements contribute towards the control of the projects and its success.

The previous literature alludes the diverse application areas of visual controls and mostly emphasizes on the role of VM in workplace structuring and orientation (Hirano, 1995; Galsworth, 1997; Liff and Posey, 2004; Mann, 2005). The authors in that literature delineated the diffusive and universal application of VM strategy in workplaces. Galsworth (1997) also reflects this view by noting the importance of visual management in workplaces. In her study, she established a recipe approach which illustrates how the visual methods should be approached that will facilitate any process or project improvements. According to Mestre et al. (1999), visual communication contributes a significant effect on Japanese corporate culture. In the corporate culture, communication relies both on top management and from top management. Visual workplace provides those key communication factors that assist in co-operating with organization employees to improve performance. In the previous study, the authors revealed an interesting fact that people generally use five senses whenever they learn something, but most of the learning portion (approximately 75 percent) is done by sight. That literature in most cases emphasizes the practical applications with some conceptual discussions. On the other hand, the positive side is that the research was done profoundly with some narrative description of VM.

The concept of visual management can also be utilized for the enhancement of manufacturing environment efficiency through the visual guides (Grief, 1991). Grief also described that providing similar concise visual information to everyone could lead towards the flexibility of managing projects. Moreover, VM is often mentioned in the lean production research where VM acts as a supportive role of performance management (Bhasin, 2008; Hodge et al., 2011), workplace organization (Bhasin and Burcher, 2006) and continuous improvement (Hodge et al., 2011).

In some other literature, visual management is often referred to as 5S (Sort, shine, set in order, standardize, sustain) which is an acronym that was developed by the Japanese in

the early 1980s (Warwood and Knowles, 2004). The term 5S has often taken into account for safety purposes. Safety was considered in terms of ergonomics and physical hazards in some areas. Another type of research emphasizes on principals and discuss some barriers of the functions of VM and their outcomes. Formoso et al. (2002), discussed the process transparency which is observed in work setting through VM. Common missing elements in some previous research is the role of visual management in dealing with projects or project management strategy, which hinder some broader aspects of understanding this subject in its different dimensions.

Therefore, it can be conjectured from the literature that there exists a diversity of definitions, explanations, and perception of visual management. Some scholar viewed VM as a management strategy to control organizational activities. Some of them defined it as a process or performance improvement tool which is utilized to externalize information and communication in the workplace. Nevertheless, the concept and actual purpose of visual management can be explored more profoundly relying on the area of utilization and expected desire outcomes.

### **2.1.1 Functions of visual management**

A literature review was conducted to ascertain some functions of visual management. This part of the research constitutes some conceptual discussion about the significance of visual management and its tools which are implemented in diverse areas, for instance, projects, and process or within the organizational environment. It is an obvious prerequisite to comprehending the functions of various visual tools despite utilizing them directly. However, the previous study portrays that several organizations require some specific, out-of-template visual management solution that remains unexplained. This raises the essentiality of clarification for a reason to implement visual management strategy in the workplace. Therefore, it is imperative to explore the visual management functions that could enable any projects or process to connect their strategy.

Table 1: Functions of visual management (Adapted from Tezel et al., 2009)

<b>Functions of VM</b>	<b>Definition of Functions</b>	<b>Alternative Practice</b>
Transparency	Establish communication between production process or its parts with the people	Information preserve in people's minds and on the shelves
Discipline	Developing a practice of following correct procedures	Warning, scolding, inflicting, punishments, dismissing, etc.
Continuous improvement	An organization-wide process of centralized and contain incremental innovation	Static organizations or big improvement leaps through considerable investment
Job facilitation	Conscious attempt to physically and/or mentally ease people's efforts on routine, already known tasks by offering various visual aids	Expecting people to perform well at their jobs without providing them any aids
On-the-job training	Learning from experience or integrating working with learning	Conventional training practices or offering no training
Creating shared ownership	A feeling of possessiveness and being psychologically tied to an object (material or immaterial)	Management dictation for change efforts, vision and culture creation
Management-by-facts	Use of facts and data based on statistics	Management by subjective judgement or vague terms
Simplification	Constant efforts on monitoring, processing, visualizing and distributing system-wide information for individuals and teams	Expecting people to monitor processes and understand the complex system-wide information on their own responsibility



Unification	Partly removing the four main boundaries (vertical, horizontal, external and geographic) and creating empathy within an organization through effective information sharing	Fragmentation or “this is not my job” behavior
-------------	--	--

For the better understanding of the identified functions and their possible contributions is presented below:

**Transparency:** Transparency is defined as the communication capacity of a production process (or its parts) with the people (Formoso et al., 2002). Through ameliorating the process flow through removing visibility barriers, integrating information into process items and measuring and visually displaying the measured, process transparency can be increased (Koskela, 1992). Transparency provides facilities to the management to get an explicit update about their ongoing process or any projects. For this reason, it is required to deliver transparent information at the workplace for both the superior and subordinate. However, information nowadays is so diffusive and in that case, transparency plays the role of replacement through optimizing the hierarchical communication where subordinates rely on their superiors for information acquisition and access. Nevertheless, information flows and is openly accessible to workers, managers, customers, and visitors without hierarchical dependencies or structures (Harris and Harris, 2008). According to Hodge et al. (2011), visual management does not encourage to discard managerial control slightly it enhances the information available to mitigate the non-value added activities, for instance, asking similar questions, counting, guessing and so on.

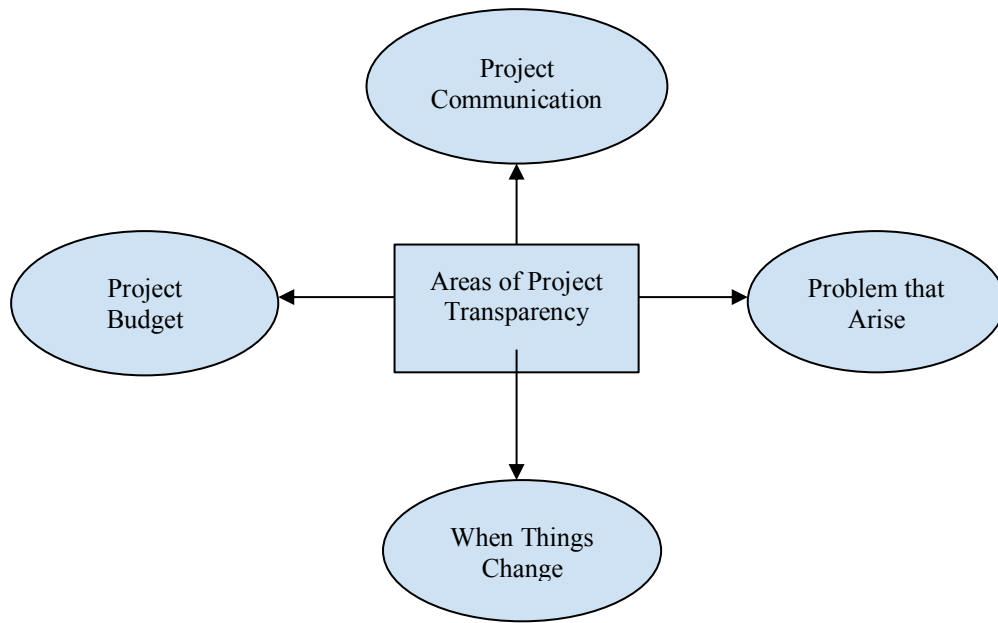


Figure 2: Focus areas of project transparency

**Discipline:** Discipline refers to habitually maintaining a correct procedure (Hirano, 1995). Galsworth (1997), illustrates that discipline can be acquired through several degrees by directing, limiting and influencing people's characteristics with the four types (visual indicators, signals, controls, and guarantees) of visual tools. Meanwhile, in terms of project point of view, project related processes could be associated with consistency. In addition, process discipline corroborates some rules and actions which assist in gaining consistency in the project within a continuous process iterations to ensure the ultimate desired outcome. Discipline has close integration with the standardization of process. By visualizing overall requirements, detail work instructions, particular work specifications and continuation of the process in an attractive, easily accessible and easy to understand manner, standardization can be achieved. After that, the ultimate result leads to continuous improvement. Hodge et al., 2011; also suggested that being able to observe the process more visibly also anticipated to identify the deviations that may lead to continuous improvement.

However, according to Galsworth (2005) discipline is concerned with the minimization of waste and as a part of visual management it eliminates six core questions (the what, the where, the who, the how, the how many and the when) which have a substantial

probability of turning into waste in some cases. Moreover, through the discipline visual management influence or standardize the outcome so that it can create indulgence towards the organizational goals. In fact, discipline has several levels namely, influencing, directing, limiting and guaranteeing that are linearly comparable with the identical parameters (Figure: 3). The arrows in the figure indicate the increase or decrease of discipline levels in terms of different parameters indicated on the box. For instance, the suddenness of the desired outcome in the box will be increasingly moving from a lower outcome (Influencing) to higher outcome (guaranteeing).

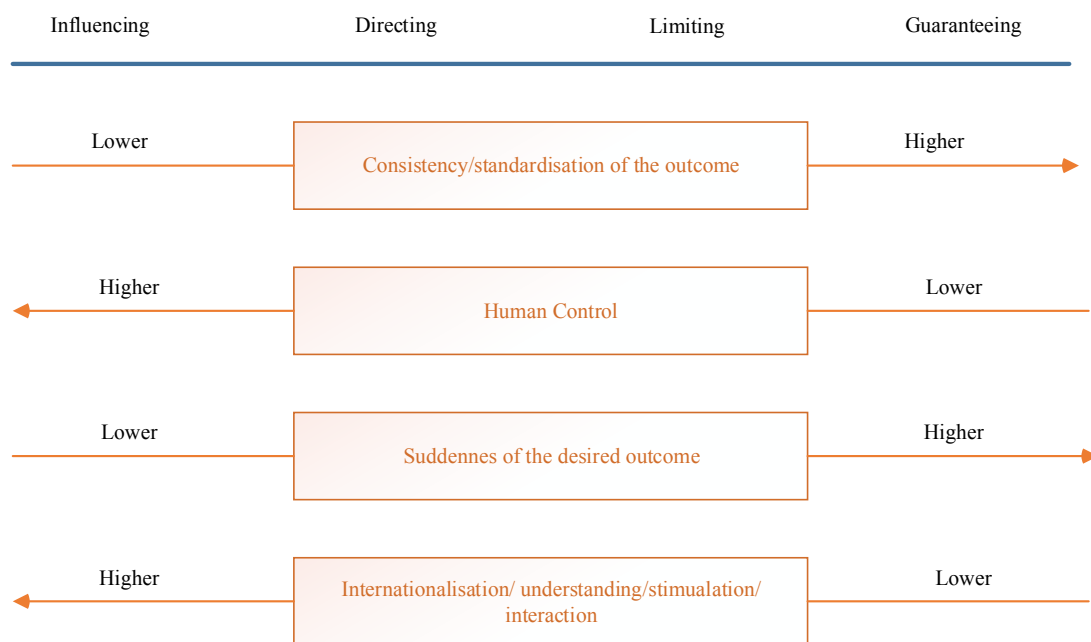


Figure 3: Different types of visual discipline (Adapted from Tezel et al., 2009)

**Continuous Improvement (Kaizen):** It is described as an organization-wide process, which has a highly dynamic capability and sustained incremental innovation (Bessant and Francis, 1999). Visual management provides the base for continuous improvement and animates the participation of the workforce in the improvement process. In addition, continuous improvement stimulates the involvement of employees to manage projects and improve quality (Grief, 1991). The participation of visual tools identify the deviations from the standards through process transparency and discipline to communicate improvement suggestions (Mann, 2005) which facilitate the understanding of the problem-solving techniques and their implementation process. Furthermore, constituting the future improvements, the inevitability of a new standard will emerge which will be the outcome of the continuous improvement effort.

Thus, following the obligations of continuous improvement cycle (Figure: 3) the organization as well as their employees can trace the deviations from the standard level and create an opportunity to improve it through modifications or developing altered standards as an outcome (Grief, 1991).

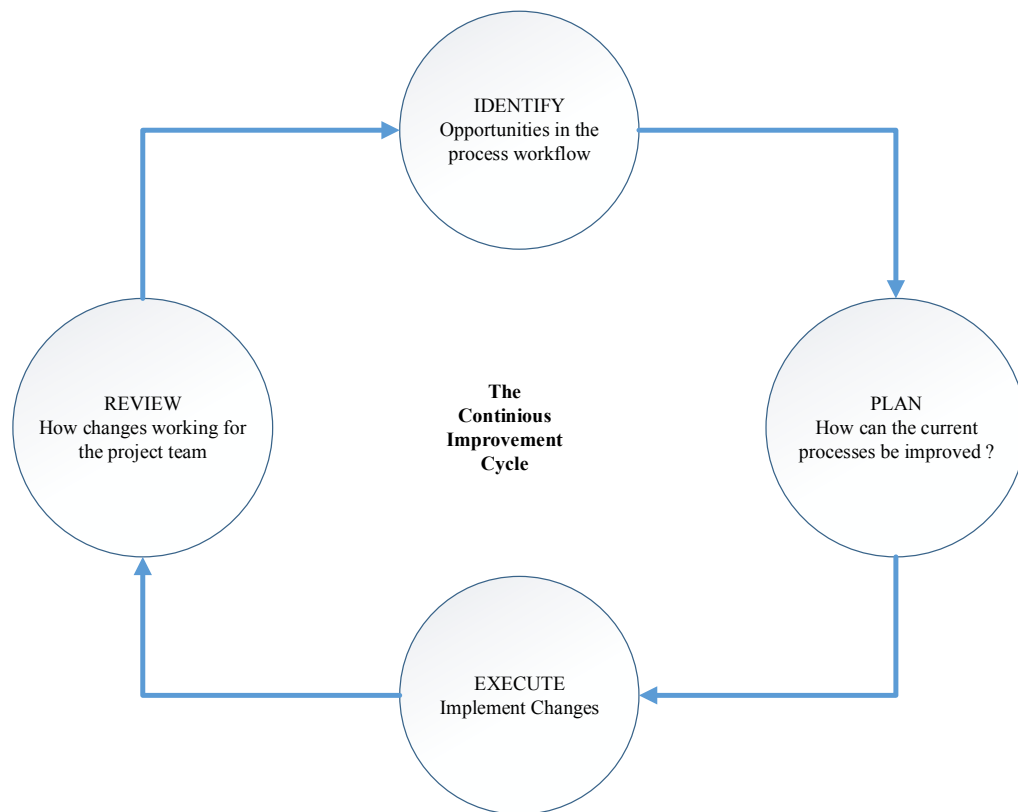


Figure 4: The continuous improvement cycle

**Job facilitation:** Job facilitation can be defined as a continuous attempt to relieve efforts thorough systematic routine tasks and offering essential visual aids. Visual management facilitates people's indulgence to perform their duty with a quick, correct and holistic manner, additionally providing them with ease of duties and mental workload according to the physical implication of their job obligation (Galsworth, 1997; Greif, 1991). Visual communication and accurately designed visual tools can be of vital contribution to complete the specific task within the project. Whenever the information required to accomplish a specific task pushes the capacity of working memory, the information must be available in the physical world through visual displays (Norman, 1998). Generally, job facilitation has been researched and studied under the subject of human factor and ergonomics in Industrial Engineering and System Design. Furthermore, visual

communication associated with visual aids has the ability to eliminate drawbacks in the field of manufacturing and enhance linguistic communication.

**On the Job Training:** Effective way of learning is integrating it with work at the competitive environment. Integration with actual work setting facilitates the employees to acquire knowledge through practical experience. Sumner et al., (1999) illustrated that the integration of work with learning creates a competitive imperative for the organization. On the Job, training has a close connection with continuous improvement. It disseminates unnecessary information that provides cost-effective tools to ensure less work disruption and at the same time encourage the employees towards practical learning practices under visual management.

**Shared Ownership:** According to Pierce et al. (2001), psychological ownership can be ascertained as a feeling of possessiveness and psychologically being tied to an object (material or immaterial). Usually, visual management is used to generate and entitle the territories and form teamwork (Grief, 1991). Meanwhile, another function of visual management is developing an image for the stakeholders (Liff and Posey, 2004). The concept of shared ownership clinches the interpretation for any production system and a company as a whole to achieve the strategic target. The involvement of visual signs and systems accentuate to preserve organizational caring and supporting culture as well. For instance, whenever a potential candidate is involved in a visual management organization, the animated atmosphere anticipated with visual aids for employees generate positive impressions and enthusiastic sense of support in his/her mind. Moreover, Mestre et al. (1999), indicated that the participation of visual elements simplify the utilization of signal group membership, synchronize the member's responsibility with organizational vision and culture, maintain organizational vision and manage and develop human relations. Nevertheless, Visual management can expectedly be constituted of indulgence to instill an open and sharing network within the organizational culture and accomplished specific task or project.

**Management by Facts:** It is described as a collection of facts that have been used and the available data based on statistics (Gunasekaran et al., 1998). Through the flow of information visual management facilitates the opening of objectives of organizational reality to the relevant personnel (Mann, 2005; Liff and Posey, 2004). This reality is

exempt from personal bias or understanding of the individuals within the organization. However, the collaboration of visual management eliminates the information monopolies at different layers which instigate the people to face their own performance reality (Grief, 1991; Liff and Posey, 2004). Simultaneously, the introduction of various project performance board, signs or posters, the authorized management is enabled to acquaint the employee's organizational strategic goals and expectations and valued behavior. Therefore, visual management ensures the divergence of dissipation of information and control the implication of performance of tasks for a certain focus objective.

**Simplification:** In the dynamic and complex environments the management information sometimes passes beyond the reach of people's efforts and capabilities. Usually, companies tend to make their strategic decisions based on their strategic information. Mismanaged information due to deficiencies of information or information overloads is merely the reason for poor performance, stress, disagreements, conflicts, and unawareness of any ongoing projects (Eppler and Mengis, 2004). However, visual displays serve as knowledge transfer function which is integrated with the environment where design has been organized for the user. The visual elements are sustained and updated on a regular basis that originates the feedback mechanism for the user to monitor the overall progress and performance of current tasks. Nevertheless, as an information management tool, the participation of visual management simplifies the information that can be significant, performance uprising and sufficient for the project related activities.

**Unification:** Typical Organizations have vertical, horizontal, external and geographical boundaries which can partly subside through systematic information with the stakeholders (Ashkenas et al., 1995). Visual management serves a wide range of vital functions in the organization. Unification enhances the process of transparency in day-to-day operational practices. In terms of control of any task, unification provides the available information that supports the organization to make out the best of human resources and assets. Those resources have the greater ability to generate ideas, information, talents and actions which are mostly required for the project. There might be the existence of a border between the task and assigned group. Unification diminishes the border between these two which results in effortless multiple task handling or ease of job enlargement for the employees (Hirano, 1995; Glasworth, 1997). Nevertheless, visual

management function as a unifier, wipe off the inevitable effects of fragmentation and organizational boundaries and ameliorate the unified knowledge management efforts.

### **2.1.2 Visual management tools**

The contribution of visual management is ascertained through combination of visual tools. It is necessary to comprehend the role of those tools in different aspects of application. Some of these tools are distinctive in nature which is cited so much. As a result, so often it overshadowed the managerial strategy of a company. In Kattman et al. (2012) describe that it is not very arduous task for an employee to originate a visual tools in his day-to-day information requirement. According to the McCormack and Willaert (2008) illustrate that visual tools are utilized as a language of change and how this change synchronized with organizations process oriented language to develop a mutual comprehension. On the other hand, Greif (1991) found that visual tools are integrated and can be openly exposed within work environment which enables easy-to-reach and easy-to-see opportunities. However, there are four common characteristics have been found on the visual management tools (Greif, 1991; Galsworth, 2005; Harris and Harris, 2008):

- Firstly, visual management is exerted to generate required information field in the workplace. As a result, people can freely acquire essential information in a self-service manner
- Secondly, to prevent information deficiencies, visual tools follows the preemptive approach that determines information requirement ahead of time
- Thirdly, the information exhibits in the display is totally integrated into process elements i.e. equipment, machinery, materials, gadgets, tools etc. It create an direct interface between the operator and the process element
- Finally, with the assistance of visual tools facilitate the simple method of communication and relies little or not at all on verbal or textual information

Galsworth (1997) discussed some general classification of visual tools, i.e.: Providing information (e.g., signboards), Medium of Signalling (e.g., andon boards), limiting the response or controlling (e.g., kanban cards) and lastly, guaranteeing the response (Poka-yoke systems). Mestre et al. (1999) described that 75 percent of learning was done through visual sight. Moreover, this paper also suggested that visual tools can be exploited into the members of the signal group where they are animated with

organizational goal, strategy, vision, and culture. Additionally, visual tools manage the relationships among employees and business communication, etc.

However, it is also contemplated that several visual tools can create confusion to understand the usage of tools under what purposes. A summary can be concluded which indicates how to use visual tools with their definition, roles in the operation and project management and their implication according to the several authors in the following table 2:

Table 2: Visual tools taxonomy

<b>Visual Tools</b>	<b>Definition</b>	<b>Practical Application</b>
One point lessons (OPLs)	Short visual sheet to promulgate new idea, knowledge and critical point of a specific topic. e.g. Case study or continuous improvement sheet (Bessant and Francis,1999)	Dedicatedly support and pass better knowledge towards quality, safety, equipment and operational management department for enhancing the process and strengthen the understanding among the employees.
Value stream maps (VSMs)	Facilitate the visual documentation of the crucial information and process materials required to finalize the successful projects (Rother and Shook , 2003)	Abridge the process from beginning to end visually. Ascertain the possible bottlenecks within the process and enhance the communication among the stakeholders and employees. Planned the future of state of process.
Andon-electronic displays	Exhibits the recent status of process. It is an audio-video signaling boards communicating about stopped or ongoing process. (Monden,1998; Galsworth,	Enable supervisor to take decision promptly if problem arise. Increase accountability of employee and ensure the quality and safety issues. Enhance the flow of information between management and personnel.



	2005; Harris and Harris,2008)	Identify deviation and create an opportunity of continuous improvement.
Heijunka boards	Visual boards often interconnected with Kanbans (Harris and Harris,2008)	Reduce overtime and inventories. Ensure stability in the workloads
Mistake proofing (poka-yoke)	An electro- mechanical systems to control mistakes before it occurs and probability to turn into defects (Shingo, 1989; Saurin et al., 2012)	Optimize the participation of quality control. Reduce defective services and improved safety measure. Assist the preventive measures activities.
Kanban Systems	Referred as a visual signals to “pull” product or service from preceding units or departments (Ohno,1988; Hirano,1995; Monden, 1998)	Synchronize the planned task with the actual task at on field. Facilitate the smooth service flow and ensuring the quality task. Minimize the risk factors in complex projects and reduction of inventory obsolescence.
Control tables	Tracking boards of ongoing task visually(Mann, 2005; Brady, 2014)	Increase transparency and control projects. Enhance the visual communication and awareness among the employees. Established better coordination and control the human resources properly.

Standard operating sheets (SOSs)	It's a visual instruction demonstrate the operational procedure, duration, identifies some critical points etc. (Lyons et al., 2013)	Standardize the process for maintain consistency in progress. Eliminate guesswork and wastes. Optimize the mistakes and variations. Enhance personnel job delegation and ensure safety manners.
Signs, labels, name tags and direction lines; Borders, shadows and coding	Systematic management of workplace thorough structuring and housekeeping efforts (Hirano, 1995; Monden, 1998)	Facilitate better orientation of workplace. Reduce the learning curve and wastes. Ensure workplace safety. Take preventive maintenance. Make an easy way to identify and deviations of problems.
Pareto charts, sticky boards, decision trees, A3s	General visual tools and systems that support the continuous improvement process (Greif, 1991; Galsworth, 2005)	Improve problem-solving techniques. Abridged and enhance communication of the process.

Through analyzing the literature review and the role of different visual tools, a framework has been developed for creating a visual workplace in Figure: 5. The framework is the basic constituted by visual performance centers/ Obeya Rooms, Visual standards and 5S. According to the Hirano (1995) and Galsworth (2005), it was suggested that the basis impose the standards for more in operational concepts, for instance, visual controls, signals, and visual guarantees. However, the upper portion of the framework indicates the inclusive improved visual workplace. This portion supported by the visual continuous improvement tools obtains new knowledge and earned knowledge dissemination methods and visual management tools for external and internal marketing. This framework was considered as a practical visual workplace implementation indicator. Moreover, this framework proposed an essential design proposition that facilitates for creating an

effective visual workplace as well as conciliates the given sets of practical visual aspects. Eventually, after analyzing previous literature, it was observed that similar types of practical implementation framework were missing in the lean study. Furthermore, this framework was evolved only from the literature analysis and undoubtedly, there is a requirement to conduct exploration that is more practical, in the field of visual management.

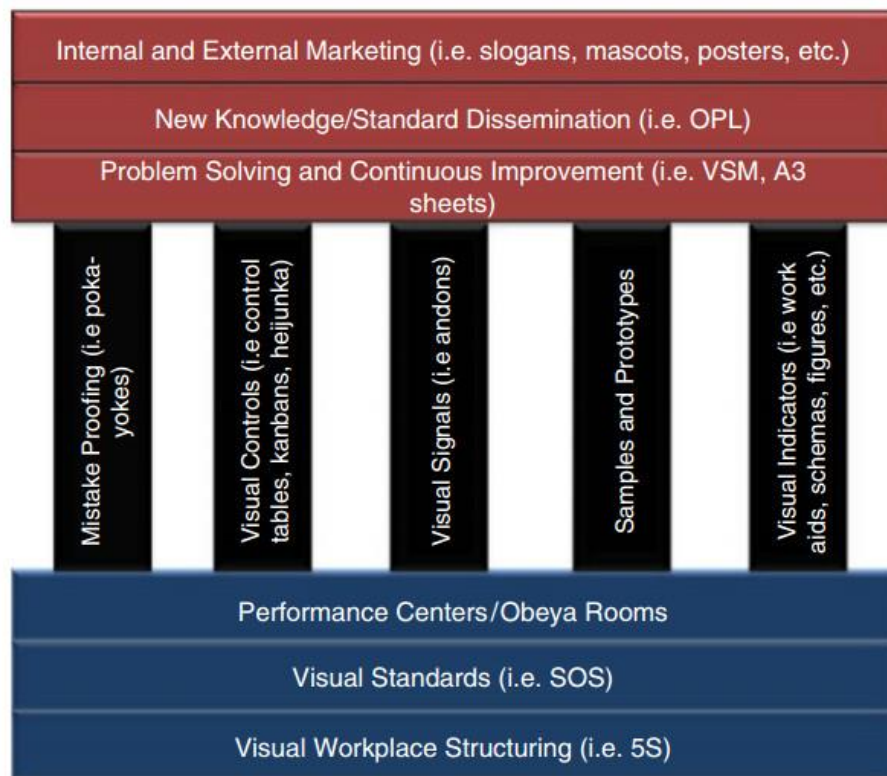


Figure 5: Visual workplace implementation framework [Modified from Hirano (1995) and Galsworth (2005)]

The diversity of visual tools confuse the application and it is always recommended to choose the visual tools according to organizational setup and competent purposes since project managers are often tempted to copy simply looking visual tools not judging the exact project settings. Establishing a flawless visual management tool within an organization secure organizational connections and maintain a certain organizational readiness which is considered as a prerequisite. Otherwise, the performance and feedback from most of the visual tools may not yield the desired contribution. Furthermore, some of the visual tools are as sophisticated as kanban that they may hinder the project

progression and degrade overall project performance. Carelessly adopting the visual tools may lead towards negative impacts such as excessive or deficient work in progress, disruption of material or delivery flow and stakeholders or quality-related issues (Spearman and Zazanis, 1992). However, Spear and Bowen (1999) explained the Toyota visual tools utilization process as follows:

*“Toyota does not consider any of the tools or practices – such as kanbans or andon boards, which so many outsiders have observed and copied – as fundamental to the Toyota Production System. Toyota uses them merely as temporary response to specific problems that will serve until a better approach is found or conditions change.”*

In particular, the visual strategy is to create an effective mode of the communication interface between human and process element through employing visual tools. Tools are designed according to particular design principles and techniques so that application can be explicitly perceived and they are not adopted randomly.

### **2.1.3 Applications of visual management**

The concept of visual management is a common phenomenon in manufacturing industries. The term visual management is often referred to as a 5S. The application of visual management is initiated by the implementation of 5S in the workplace (Galsworth, 1997). 5S represents five Japanese words that are *seri*, *seiton*, *seiso*, *seiketsu*, and *Shinsuke* and later after translation, these Japanese words stand for the organization, cleaning, neatness, standardization and discipline. The publisher Productivity Press Americanized those Japanese words as *sort*, *shine*, *set-in-order*, *standardize* and *sustain* (Ellis, 2004). Liker (2004) described 5S as a series of activities that can eliminate waste and enhance activity performance and alleviate errors and defects. Often it can be argued that visual management has been evolved through some set of unconnected efforts by the practitioners. The development of visual tools emphasizes on such efforts that could conciliate the specific information requirement problems. Due to the intuitive design of visual tools, simple, functional arrangements enable the management to control the misleading of information within the organization. Consequently, introducing standards, removing clutters and increasing the productivity workplace can visually improve.

However, in the literature of Galsworth (1997) and Liker (2004) described different types of visual tools. Galsworth (1997, p. 309) defined visual tool or devices as a:

*“A mechanism, gadget, or apparatus that is intentionally designed to make workplace information vital to the task at hand available at a glance – without speaking a word. The purpose is to influence, direct, limit, guarantee or otherwise impact human behavior relative to a specific performance process or outcome”.*

Moreover, Galsworth (2004, p.44) portray the visual workplace environment after utilizing the visual tools as a:

*“Self-ordering, self-explaining, self-regulating and a self-improving work environment where what is supposed to happen, happens on time, every time because of visual devices.”*

The research of Galsworth (1997), identifies several types of visual devices that are designed in such a way which is compatible with the structure of human behavior. Galsworth (1997) also found that those visual tools construct the structure of visual management and those devices can be classified in four different ways: 1) Visual Indicators 2) Visual Signals 3) Visual Controls 4) Visual Guarantees.

Table 3: Classification of visual devices

<b>Classification of Visual Tools</b>	<b>Definition</b>	<b>Application</b>	<b>Examples</b>
Visual Indicators	Relays information for influencing behavior although human control of disobedience is high with minimal effect (Greif, 1991)	Feasible way of communication from management to operational level	Team boards, charts, photos, value stream maps etc.
Visual Signals	Enforce more human control by using visual stimuli compared to	Seek attention in the workplace and directs human	Andon Boards: Able to call team leader visually

	visual indicators behavior and audibly in (Galsworth, 1997) case of abnormality occurs in workstation
Visual Controls	Communication devices Complete human Color coding, that enlighten people how control and all the maintenance things should be done and control systems Kanban, exhibits the deviations at are integratable markings, safety a glance, provide instant with process regulations etc. feedback how they elements like actually perform their equipment, jobs Liker (2004) inventory etc.
Visual Guarantees	Known as mistake proof, Ensure the Built in fail-safe, Poka-Yoke elimination of mechanically or device where prevention human error and electrically into information is installed create a mistake the device like (Galsworth, 1997) proof ambience automated control machines

Moreover, throughout the research of Galsworth (2009), she proposed a framework (Figure: 6) about the application of visual management. This proposed framework starts from the bottom tier and continues working in the upward direction. In the bottom tier is the visual order, which indicates the process of systematic standardization of workplace, tools, materials, warehouse, etc. It's basically considered as an application of 5S in the workplace. In the following level, visual standards that deliver standard visual display and furnishes individuals with standard visual principals and visual representation to use for their errands for instance procedural measures composed written specifications, etc. are included. In addition, this level is used to implicate diverse visual tools which make the information promptly accessible, as a result, the members involved in the process can

reply the center inquiries of where, what, when and who for successful in decision making.

The visual measures also referred to as information ought to be made transparent for administration, sub-contractual clients and providers so that the practical information regarding the must be clear to all. According to Galsworth (1997) and Greif (1991), visual measure demonstrates the compatibility (at that point and now), highlight the variations from the norm and involve remedial activity. Various visual controls, including visual pull production, controls to mitigate risks and are adopted in the visual controls. Finally, the top level alludes the mistake-proofing device or Poka-Yoke which are used to reduce the human blunder.

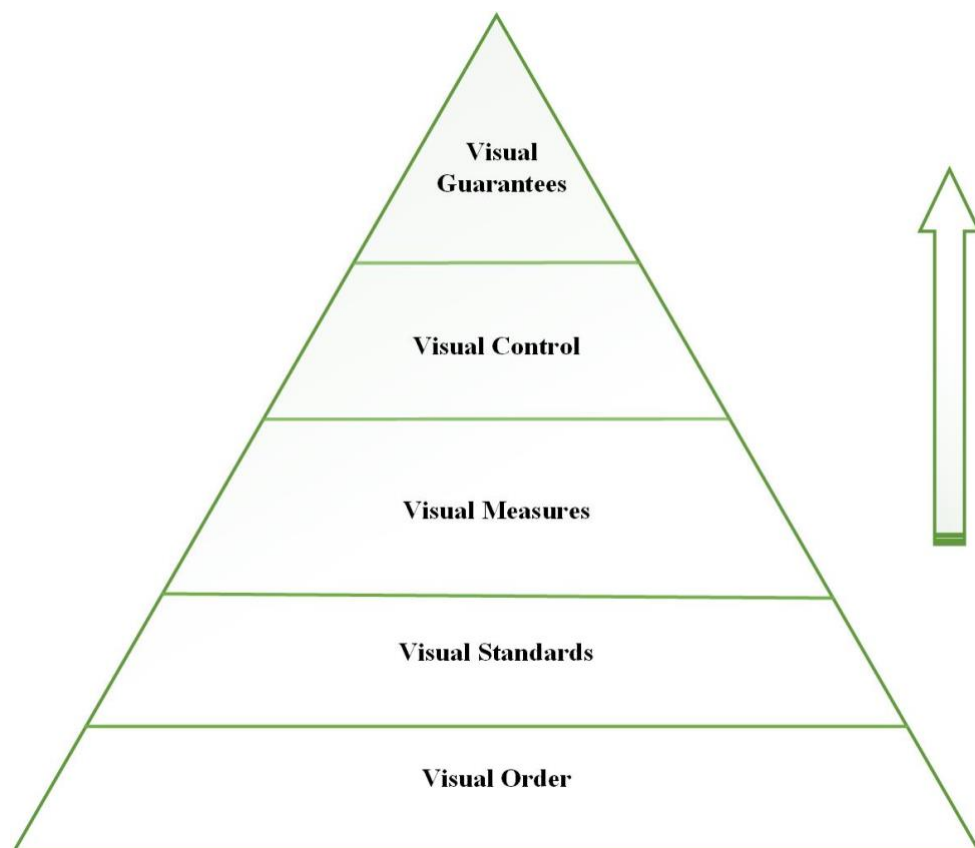


Figure 6: Glasworth's (2005) application framework for Visual Management

## **2.2 Visual project management tools**

The visual tools upgrade comprehension of complex projects and established backings for administration for high volumes of divergent information point. In terms of any project, the purpose of the visual tools is to evolve the conceptual idea and thought development forms. Additionally, throughout the project, the participation of visual tools cultivate a standard dialect for discussions and talks among the individuals within the project team. Form the various visual tools only a few of them are accessible to rundown in the project management practices and control the project. The following sections allude the most immediate, day to day practically used visual tools with their impacts on the project.

### **2.2.1 Mind mapping**

On a broader margin, Mind Mapping is envisaged as the most mainstream visual tool. Initially, this tool was initiated by Dr. Joseph D to aid student learning about the latest discoveries of science. Novak (1998, p.9) illustrate that "the main purpose of education is to possess the learner to take charge of their meaning-making which includes thinking, feeling and acting." Each of these components must be incorporated together for genuine information and mind mapping. Later on, Dr. Novak and famous British psychologist Tony Buzan promoted the visual technique by the several sense-making activities and named this tools mind mapping.

Mind mapping is a simple mode of the diagram which outwardly presents the visually organized information. Besides proponents states mind mapping enhances an individual's ability to memorize information; most importantly, it connects that information which relates to other concepts and facts. Mind maps are simple, manually written reports that are used to catch notes, thoughts musings, and remarks. Afterward, numerous product bundles have additionally been created which converts manually written notes into an adequate configuration or to encourage the catch of thoughts progressively. Usually, mind mapping utilizes the various visual symbolism and parent-child connection to capture and distinct the strings of thought. Each thought triggers other affiliations and thought designs, prodding amazingly and spurring one more string of thought.



In the research of Frey (2004), he depicted mind mapping as "an intense tool for dealing with the project's, goals and objectives, furthermore to do lists." Besides, he also stated, "mind maps empower you to gather, oversee and share a substantial assortment of information and resources promptly- embellish them a perfect tool for overseeing projects." Meister, W. (2007), illustrated that "mind mapping is an intense tool that offers extraordinary adaptability, innovativeness and allows the project manager to accumulate, manage, share and communicate the necessary information with the stakeholders promptly and effortlessly." Moreover, it is an ideal place to store, screen and monitor all the information which includes primary objectives, strategic goals, plans, scope, turning points, milestones, risk analysis, quality necessities, reports and more.

In other words, Marker (2006) abridged these tools as: " mind mapping tools and techniques go past the restrictions of rudimentary Microsoft Project designs and Excel issues lists that permitting the project pioneers to characterize project scope visually, distinguish potential risks, allocation of assignments and capture meeting minutes."

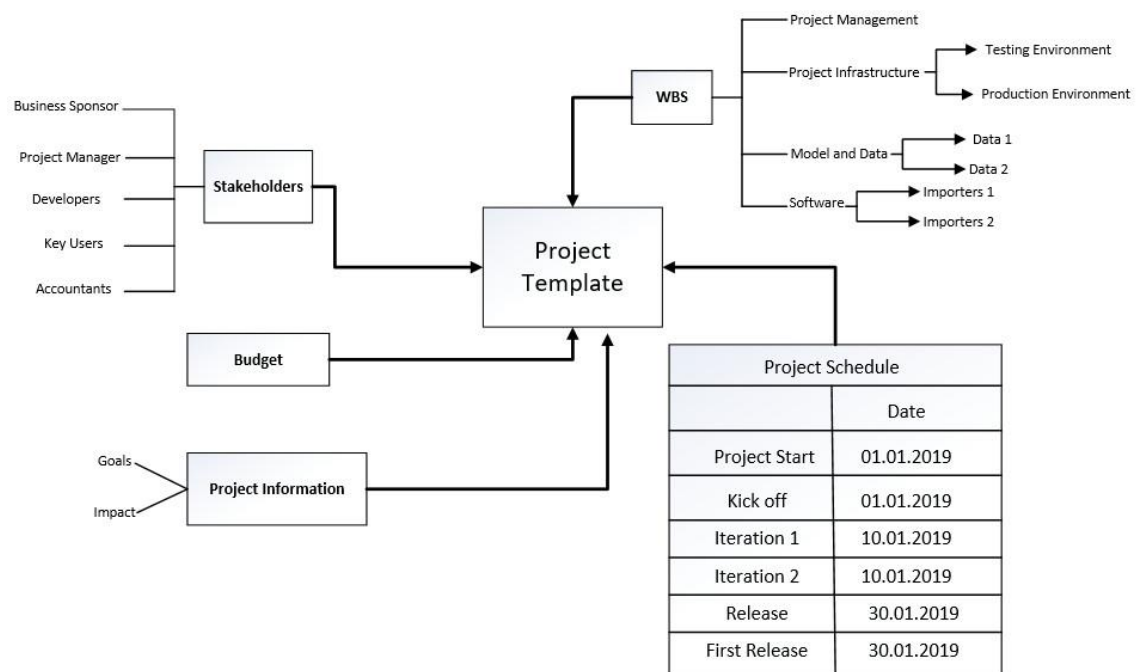


Figure 7: Mind mapping for project management

Meanwhile, mind mapping provides a multidimensional, profoundly productive and beneficial, adaptive and versatile solution in the project management. Mind mapping can be utilized for the following reasons:

- Conceptual ideas, thoughts, methodologies and strategic goals

- Undertaking proper planning can ensure the project quality and respectability of customary venture arranging but displays striking effortlessness and adaptability.
- Critical thinking
- Create activity things with updates and email warning
- Management project risks
- Stakeholder management
- Checking and Controlling overall activities

Moreover, the following table alludes the significant area of utilization of the mind mapping tool in the project management and its way of working in projects:

Table 4: Application of mind mapping in project management

Area of Utilization	Working Procedure
Project Scheduling	Manage Project schedule through dynamically linked Gantt chart
Project Budget	Access all the financial information by opening existing or new spreadsheet in Excel
Project Risks	Conceptualizing and generating list of risks incorporate with decision analysis software and notify in the dashboard for frequent reminder
Communication	Generate link to all relevant information within project and excellent medium of overseeing and presenting information so that all the stakeholders get access in the project information
Quality and Planning	Maintain quality standards, policies and manage plans.

Document	Project plans and documents can be linked and made accessible
Monitoring and Controlling	Display high level of key information in the “Dashboard” from any levels or layer of information, down to the most detailed level to control and monitor project

Nevertheless, mind maps can be conformable from the idea and strategic system development until the end of the project. Any information and its function that cannot be performed inside the mind mapping guidance is deliberately connected to the appropriate documents or program for simple access at the snap of a catch. However, the most convenient fact of utilizing mind map is that one can acquire a higher degree of systematic view or a perspective of the big picture instead of the divided view displayed by single measurement programming programs. Subsequently, the slow improvement of project management discusses the need to oversee turmoil or bring agility to the management of the project. Therefore, mind mapping is a profoundly flexible project management tool and control center. Yet, these tools are not generally acknowledged by the individuals and corporations as a management tool; however, with the fundamental advantages offered, these tools may emerge extensively in time.

### **2.2.3 Process mapping**

Processing mapping is a crucial visual tool that numerous organizations leverage to guarantee business forms work productively and successfully. Fundamentally, process mapping is just a graphic portrayal of the arrangement of activities that contain overall project procedure. This tool is mostly utilized by the business examiners, project managers, and lean specialties. Mapping and outlining the process activities is commonly accomplished through direct analysis and documentation of each progression inside a procedure.

Process map act as a visual guide for picturing work forms, adjusting the framework components in a similar way that permit process improvements (Curtis et al., 1992).

Usually, process mapping facilitates the business process analysis and empowers the portrayal representation of overall activities. Rother and Shook (1999) discussed that exchange of the advantages of process mapping is frequently centered around improvements that result from reexamining forms dependent on future-state process maps. In these circumstances, the primary process is mapped and the subsequent guide is utilized to distinguish chances to enhance the main procedure. The outcome is spoken to a future-state outline which is then connected to change, and ideally enhance, the original process.

However, process maps are only one method for visualizing and controlling the project activities. Those aggregate visual methodologies have been described as an expanding straightforwardness or process perceived ability. Currently, in numerous projects, the implementation of process maps is to consider as an intermediate step for process improvements. According to Hines and Taylor (2000), in a production facility, value stream mapping philosophy improves the present state process map which provides a premise to break down the current procedure, build up an enhanced future state map and acknowledge the benefits while executing the state mapping.

In terms of controlling a project, process mapping promotes new reasoning about how the project functions are done efficiently. It features some major movements that are taken to deliver outputs, who performs the steps and where these real issues reliably happen. Process mapping is mostly concerned about the quality in which the adjustment in procedures will have the best impact on enhancing quality. Anjard (1998) mentioned that a brilliant similarity of a process map could be named as a "road map." Project management groups have become imperative to utilize this visual management tool to cover the entire lifespan of a project which includes project process like planning, implementation, tracking, and closing. Frequently, both functions are focused on engagement of fruitful project management process through working independently and separately (Table: 5)

Table 5: Functions of road and process maps (Adapted from Anjard, 1998)

<b>Road Map</b>	<b>Process Map</b>
Receive directions and convert them into pictures	Receive procedure and convert them into picture
Indicate various pathway towards actual destination	Indicate the routes where inputs travel to become real outputs
Introduce communities while passing through to reach the destination	Introduce the functions or departments which are involved and the hands-off
Visualize the connecting roads	Visualize the connecting processes
Indicates both the faster and slower routes	Indicates the area of improvement
Suggest the alternative routes	Generate ideas to improve process

Additionally, in terms of project management, process mapping is always considered as a definitive device to streamline the work and achieve the undertaking project objectives more smoothly and proficiently. The estimation of process mapping acts as a transitional advance that promotes process enhancements which are comprehensively acknowledged (Rother and Shook, 1999; Womack and Jones, 2003). Moreover, process mapping enables management capabilities to monitor the overall project progress in a given time frame. At the same time, it measures the overall performance against the expected period and original standard that was established for the project. The visual delineation of the process map set the tone for the project managers to recognize disparities in the advancement of the project. However, within the project, process maps facilitate the following advantages that could save time and simplify overall projects:

- Develop a project design within a shorter period of time

- Established a feasible visual communication system to share ideas, project information and relevant data
- Create indulgence of decision making in adverse condition and promptly solve the problem
- Ascertain potential threats within the project and find out a possible solution
- Can be developed promptly and economically
- Break down the overall process into general steps and utilization of symbols which are easy to follow
- Depict overall sequential connections of the project process
- Exhibit the overall process form the beginning to the end

It is always an arduous and tedious assignment to develop a complex project process map. Whenever the map is ready to utilize, it fills in as a valuable project management tool to control the project. A visual portrayal of the process makes it less demanding to comprehend, translate, and recollect the processes that are point by point in words. There are a few types of process maps that could help to communicate process with others:

- a. Activity Process Map: Portray both added and non-value added activities within the process
- b. Detailed Process Map: Elaborate profound analysis of each step in the process
- c. Document Map: Documents act as inputs and outputs in the process
- d. High-Level Process Map: Detail and high-level presentation of processes where interactions between supplier, customer, input, and outputs are depicted

In the projects, process mapping is used to monitor and highlight the waste, anticipate the work process relying on the project condition and established an understanding of the overall system. Moreover, the process map enables visual communication of relevant information about processes overwriting guidelines that direct the project towards its goal. Consequently, through the process-mapping project managers effortlessly plan their projects and prepare required documentation, which ultimately develops an understanding of the process.

Nevertheless, in any case, it is always useful to comprehend the value of process mapping preceding actualizing any improvement. The role of process map in the projects can be

estimated through the employee review and how it is anticipated with the comprehension of the projects guideline. Mapping process inside the projects requires the use of assets investment and expect these assets to return promptly within the desired time frame. However, the benefits appear much sooner after utilizing the current state process map in the projects and those advantages promote the further investments on process mapping in future projects.

### **2.2.3 Root cause analysis**

Root cause analysis is considered as a fundamental strategy that is utilized for any thoroughly examined task in project mismanagement and visible project issues. In some cases issues exists out of sight that may contrast from the conspicuous direction of project goals. Through the research of Munoz, Lowry, and Smith (2012), it has been mentioned that root cause analysis (RCA) can be utilized as an inevitable component for persistent improvement of projects and lessen the hypotheses activities regarding the solution of the problem. Root cause analysis is a vital part of the project that could enhance the project quality and for that reason, the ultimate value, as well as outcome of RCA, is required to be understood in all project levels. Sherwin (2011) stated that, as a visual management tool to control the project performance, RCA was initially utilized in the automotive industries to ameliorate the production quality and efficiency.

The definition of root cause analysis can be illustrated as a systematic process that is used to identify the problems or likely drill down the source of the problem. However, Sherwin (2011) defined RCA as a tool that can ascertain the breakdown or failure of a process which, when resolved and adopted some preventive measures should be taken to stop recurring. In the same thought, Wilson, Dell & Anderson (1993) defined RCA as a cause that, once removed from the sequence which is faulty and prevents the final undesirable events from repetition. Typically, root cause analysis (RCA) has a regular connection with the project related operational activities and undoubtedly this tool is valuable in getting at the root cause of operational problems. The root cause analysis allows the project manager to diagnose the problem profoundly which negatively impacted on the project performance and promptly remove it whenever it was noticed at first. It is often recognized as a "continuous improvement" tools because they dedicatedly improve the project performance and can be utilized in a repeated manner.

In any situation, sometimes the things turn out badly; in that case, it is required to determine the root cause of the event. Whenever mistakes happen, it is a common phenomenon to point the fingers at anyone. Projects managers are responsible for drilling down those mistakes and utilize the RCA while identifying. Moreover, project managers are encouraged to do Project Post-Mortems so that they could avail something from their recent work as well as learn from their mistakes. Furthermore, whenever the environment is arduous for any team members, project managers have the responsibility to create a protected environment where employees can implicate their experience freely and learn from their slip-ups. However, there are steps (figure: 8), which are the backbone for the RCA to exploit it effectively:

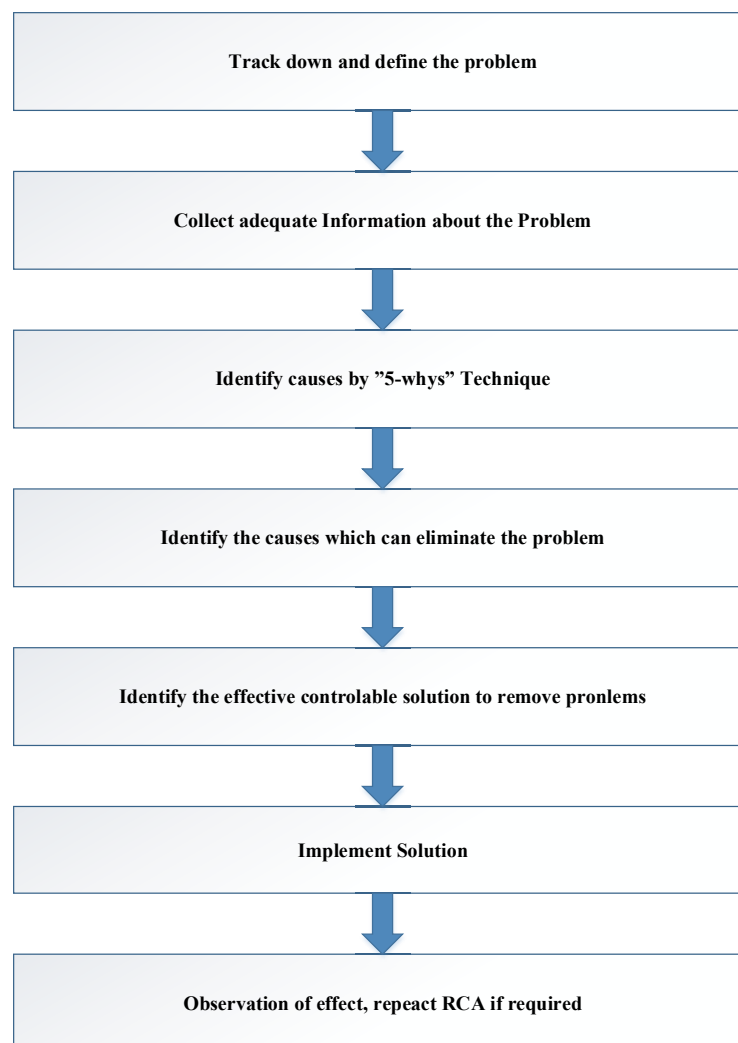


Figure 8: Steps of root cause analysis

Usually, root cause analysis follows some techniques that create indulgence for project management professionals. Beforehand, it is required to form a team to conduct this



analysis. The team then answers the questions, which is known as the "5 Whys" approach (Mengis & Nicolini, 2010). It is a question asking technique to find out the cause-and-effect relationships profoundly for a specific problem through analysis and drill down the symptoms. Relying on the situation the answers to these questions might be either simple or complicated. However, each of these answers portrays the actual event, and thus the opportunity arises to reveal the real issue. In addition, RCA can be reactive in some adverse events where errors that were caught before are still affecting any process within the project (Sherwin, 2011). Nevertheless, these techniques are most effective whenever the hands-on experience person who is related to the process examine answers to those questions. The following figure exhibits the sample of questions of 5-whys technique whenever a project team has missed out their deadline.

Issue: The project team has missed their third consecutive deadline

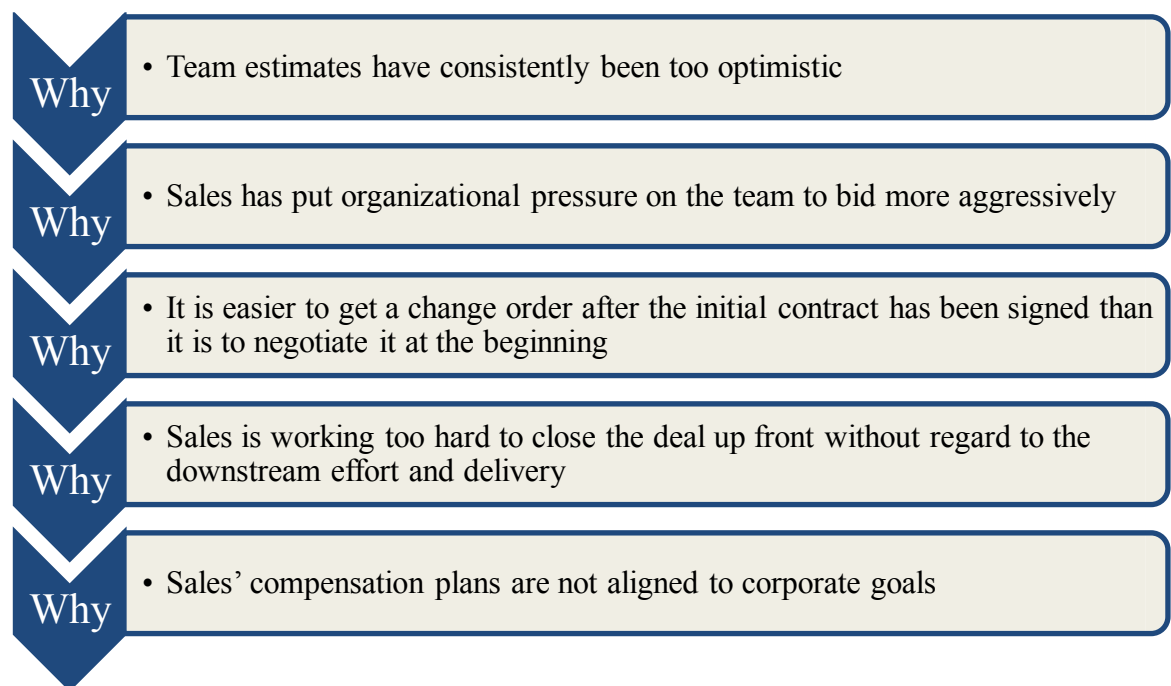


Figure 9: 5- Whys technique

Fishbone diagram is another useful technique to visualize the causes. It is also known as a cause-and-effect analysis method. The diagram shows (figure: 9), the causes of the problem aligned within the body of the fish and it ended up to head where the problem statement has been defined. Different causes that constitute the primary causes flow from the backbone towards the fish head or cause. While determining each problem, there

might be some cases, where the primary causes can also have secondary causes. This technique is commonly seen in manufacturing projects where people, process, equipment, materials, environment, and management is involved.

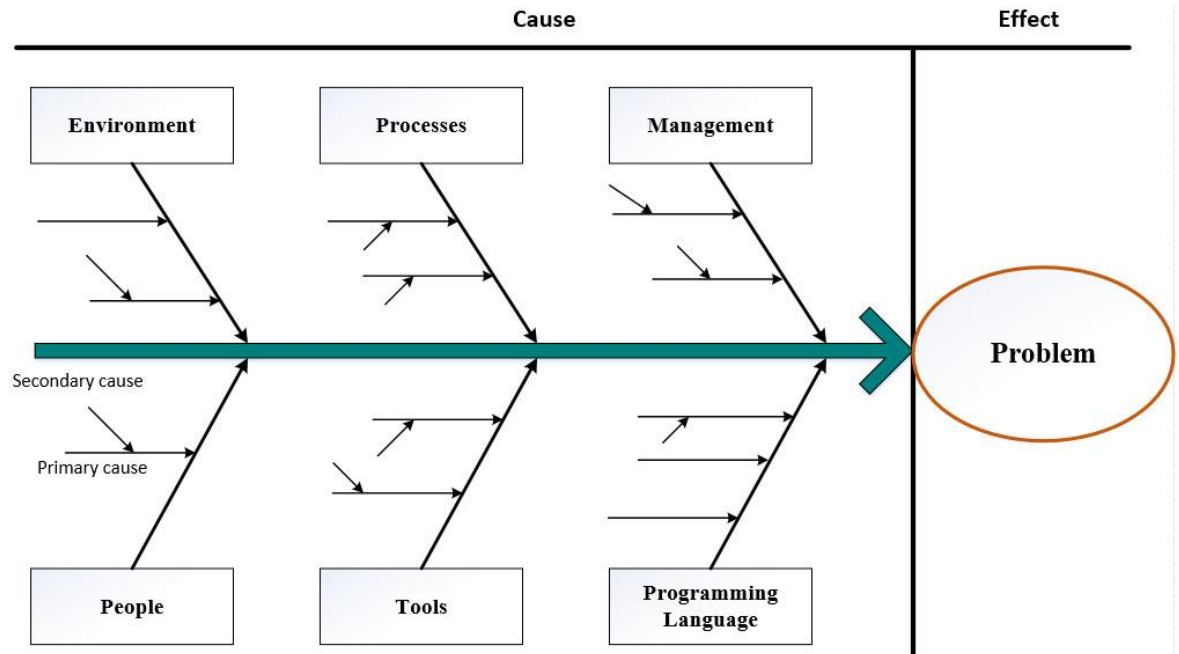


Figure 10: Fishbone diagram (Adapted from: Nielsen, 2009)

However, project managers should be careful about some complex connections among the cause and the effect. Notably, in some cases, it is not required to involve root cause analysis to identify and resolve every project problems. Problems which are laborious to solve or some strange issues will lead towards root cause analysis. Moreover, a sparse gathering of requirements during planning, engagement of inefficient stakeholder or poor communication narrow down the scope of finding the actual problem. It is recommended to follow the actual steps and not to jump over the conclusion. Hence, when all the project members agree to the existence of the problem, in that case, RCA will take advantage. Additionally, better root cause analysis within the project team members facilitate to carry out risk management, quality management and that all sums up to the creation of a learning environment.

### 2.3 Current state of visual project management

The recent global competitive environment is rapidly getting complex at an incomprehensible rate. Now a day's academics and practitioners realize the inevitability

of visual management practices to construct projects or organizations that are truly compatible for future (Ghoshal 2005; Johnson and Broms 2000). Besides, a high level of project complexity, frequent changes, and ambiguity result in unpredictable progression of projects. However, utilization of visual information facilitates the analysis of those complex activities through processing cognitively and intellectually handling of spatial orientation and introduction of the interrelationship among the project components. The involvement of visual support is the strategic goal of project management. Additionally, in recent times, an organization called the participation of visualization in project management as the primary driver for their organizational strategy (Artto et al., 2004; Dietrich and Lehtonen, 2005; Meskendahl, 2010). Ware (2005) summarized that visual management has the competency to explore a far more complex concept structure that can be exhibited externally in a visual display which can be notable in both visual and working procedure. In terms of limitations of working memories, visualization facilitates the extensions of both the capacity and duration of saved information (Tergan and Keller, 2005). In recent years, visual project management gained more attention in diverse sectors as a way of aligning the projects in a mode of strategy and undoubtedly assured the adequate resources, planning and most importantly promote the organization in extending their capabilities to control projects (Crawford, 2006; Maylor et al., 2006). This section demonstrates the recent circumstances of visual project management to control projects as well as manufacturing practices and construction and organizational division.

### **2.3.1 Project control**

Behind the success of projects, the contribution of the correct project management control system is involved. Lehtonen and Martinsuo (2006) suggested that the failure and success of projects depend on how they reach their desired goals and how they are managed throughout the process. The main task of project managers is to develop an initial robust project plan which can be done through efficient project control methodologies. Whereas the achievement of project goals is based on efficient project control (Nieminen and Lehtonen, 2008). Nowadays project managers are more concerned about developing an appropriate project control system which is one of the core components of project management effort. Moreover, recently, most of the companies and researchers are more concerned about the sustainability of project management and the characteristics of work process for managing projects (Gareis et al., 2013; Silvius and Schipper, 2014). However, the control practices of project management reduce the 15% chances of project failure

and additionally enhance the project performance significantly through dedicated project control systems. According to the Project Management Body of Knowledge (PMBOK), project control can be defined as the following:

*“Project controls are a combination of the data collection, project management and analytical processes which are used to forecast the future, understand the current state and constructively influence the time and cost outcomes of a project or program; through the information transfer in formats that will assist effective management and decision making activities.”*

In the project execution phase, project control is considered as a central part. According to Cardinal et al. (2010), project control can be defined as an "encouraging behavior that is desirable to achieving the organization's objectives". In recent years, the inclusion of visual project management practices assist the streamline of workflows and create indulgence to control projects. Visual project management facilitates the project managers to understand and determine the priorities of the tasks, their dependencies and the factors that could delay the momentum of the projects. Moreover, the study of Whyte, Ewenstein, Hales, and Tidd (2008) found that the visual practices in project management compose a bridge connection between the project work and the broader organization through ensuring the visibility via charts, diagrams and utilizing various tools. It is required for the receiver to have some knowledge in his mind or most importantly have the cognitive capacity. The visual representation facilitates the understanding of the context and the cognitive capacity of the receiver elaborate the overall scenario. This overall procedure eases the transfer of knowledge across the diverse functions for instant stakeholders and experts with several professional backgrounds.

In recent practices, the project goals are determined based on the measure of performance management which can be verified through several project control tools and continuous project health check-up (Jaafari, 2007). Project managers, at present, are keen to utilize visual project management to serve their responsibilities like visual planning, creating effective communication system among the team members, resource planning and governing the project progression (Maylor, 2010). Control can take different forms in terms of holistic viewpoint, and these forms can be divided into several control modes, for instance, formal or informal modes and control mechanisms such as rules, plans,

budgets, schedules and so on (Nieminen and Lehtonen, 2008). Organizations are most likely willing to utilize a combination of several control modes and mechanisms in different projects, and this combination can be referred as a combination package (Liu et al., 2014; Nieminen and Lehtonen, 2008).

Throughout the projects, the communication and languages used should be neutral, explicit, have some objectives to finish off and it is always favorable to skip some impulsive terms. The excellent communication mode is being characterized by the two-way process (Association for Project Management, 2012). However, Gebhardt & Krause (2016) stated that, in some point when several departments within a project have to communicate with each other, the tools of visual project management facilitate to enhance the communication performance. In addition, it is considered as an advantage to acquire an overview of a project outline about how the project will proceed and expose the concealed problems that might appear in future and nevertheless explore the way of preventing these problems (Maylor, 2010). A most noticeable part of the project is the perfect planning of the resources and scheduling of reusable and non-reusable resources. Visual project management enables the project managers to schedule resources correctly that will result in effective and efficient utilization and additionally early identifications of bottlenecks and conflicts. Moreover, through the employment of visual practices, allows the proper control and governance of the resources. However, fostering the cultural improvements provide transparency of information and encourage the management to do independent scrutiny of projects. Nevertheless, Maylor (2010) believes that to controlling the projects effectively, the following core requirements are necessary for the system:

- a. Ensure the visibility of projects progression
- b. Deliver performance feedback to the team
- c. Developing the corrective measures where required

However, ensuring these obligations in the projects, visualization provides the facilitation to the project managers so that they can ensure the transparency in the whole activities. Lindlof & Soderberg (2011) abridged that through the visualization in project management an explicit overview is fabricated that can assist the corresponding project management professionals in prioritizing the tasks. The typical large infrastructure

projects require the investment of the public sector that is associated with the long-term goals that continuously improve the specific infrastructure for instance road, tunnel, metro rail, power plant and so on. Control the vast and complex projects, the relationship between visual management and project management activities set control packages that leads towards sustainable project goals. J. Kivilä, et al. (2017), proposed a conceptual framework that illustrates a broader set of control mechanisms (e.g. visual control packages) that are directed towards the goals and sustainability of the project.

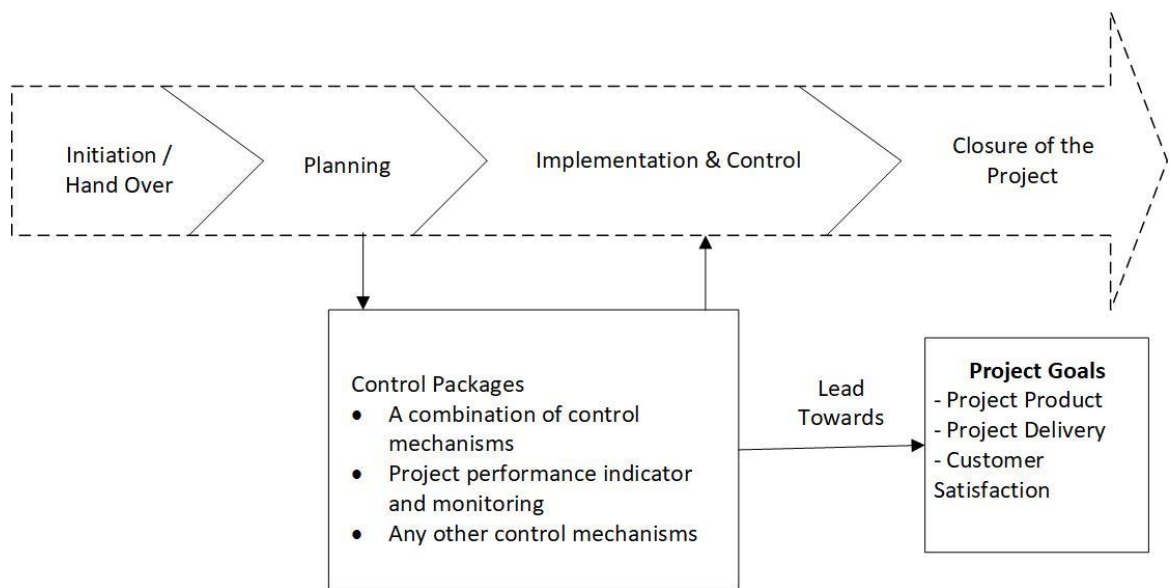


Figure 11: Project control framework towards project goals (Adapted from J. Kivilä, et al., 2017)

However, utilizing the framework, the four maintain factors the researchers identify contribution of controlling the project:

- a) The influence of activity relationship and techniques that results in effective outcomes on complex infrastructure delivery projects
- b) Relationship among the activities based on the project characteristics and the complexity to make sustainable project management outcomes
- c) Confirmation the requirements to integrate the control packages in regular project management practices
- d) Propose the future research to establish the sustainable project control techniques

The pioneers and scholars found the positive impact and success factors on the involvement of visualization in the project management through their studies. According to the case studies of Parry and Turner (2006), some of the following success factors themes which can be applied in any visual management systems to control the projects are identified:

- A team should have been empowered to create their own standard visual process management boards to adapt each specific teams requirement.
- Maintain a simple and explicit visual board without having any unnecessary information
- A colorful physical visual control system should be utilized rather than electronic system. Due to the fact, physical systems ensure more feasibility and on the other hand electronic system bring numerous unnecessary information and preferable to utilize in the small group of people who understand the software. Physical notes are flexible to change anytime by anyone.
- Top-level management must be supportive and dedicated to the visual management system.
- Make visual practices understandable to all the members to control the project effectively
- Regular follow up of visual management practices evolves into a useful tool

However, most of the previous literature emphasize project control as an internal project control mode (e.g., Cardinal et al., 2010; Nieminen and Lehtonen, 2008). The current study of Kivila et al. (2017) found some explicit connection to the external control of the projects. Majority of the project control research is also based mainly on the project manager and project team member's relationships and cover their activity to accomplish their project goals utilizing the visual project management. In comparison, another study suggested taking into account the stakeholders views on project control and collaboration in projects and their goals (Abidin and Pasquire, 2007; Fernández-Sánchez and Rodríguez-López, 2010). Moreover, the research conducted by Kivila et al. (2017), emphasized the centrality of alliance contract and of course the regulations of local, regional and national levels which can influence the project control. To maintain the effective project control system the social sustainability, economic control and

nevertheless the internal control packages are required. Therefore, the participation of visual project management is always aware of both the external and internal concern of projects and keep the managers updated about the current state of projects so that the responsible person should handle and directs the project to its goals.

### **2.3.2 Manufacturing practices**

The concept of visual management practices is not new in project based manufacturing operations. It has been broadly used in manufacturing project to maintain and control the production activities. Currently, with fast developing technology now the visual management practices are synchronized and have probably been more refined and composed in the field of manufacturing practices compared to anywhere else. Communication is envisaged as a key component for the smooth running of a manufacturing plant. For that reason, in manufacturing projects, currently confronted the challenges and concerns about the improvement of ineffective delivery of information to the large workforces with close range communication (Bilalis et al., 2002). Involvement of visualization practices converts the complex and heavily textual instructions or important safety notifications to simple visual instruction that could ameliorate the overall operational performance.

However, the various organization believes that economically affordable and cognitively effective information systems can be easily integrated with their work to ensure the availability of information at their work settings (Goodson, 2002; Achanga et al., 2006). Visual management process exhibits information in a highly flexible manner that could be supported and anticipated by the management involved within the project and employees working on a production floor as well. Moreover, it could identify the exact location of the scarcity of information where the need of further requirements might occur. Admittedly, the system describes the actual information of ongoing manufacturing project aptly, compactly and straightforwardly (Murata and Katayama, 2010). However, the visual management promote the information availability to suppliers, customers and other stakeholders about the project status and ease of information transformation to the management and team. Consequently, the contribution of visual management results in effective operating environment for the workers and allows the managers to prepare the project deliverables within predetermined delivery time (Herron and Braiden, 2006; Bhasin, 2008).



In the manufacturing plant, each targeted production envisaged as a project where the ultimate goal is to deliver the product to the customer or launch a new product into the market within a predefined period. On the manufacturing floor, visual project management expands the production rate by empowering the workers to make his or her own decision by self-direction. According to Galsworth (2004), visual management ensures the self-ordering, self-explaining, self-regulating and nevertheless the self-improvement ambiance where things happen on time, every time due to the visual monitoring tools. Moreover, Greif (1991) elaborates that in the manufacturing ambiance, the production rate and achievement of project goals is drastically enhanced through visual guidance. Greif also noticed that the involvement of visual management in the manufacturing field provides the amount of flexibility in the work so that all the employees acknowledge the similar concise environment. However, visual practices enable the workers to do their work by their guidance without any assistance of others.

In other perspectives, it has been taken into account the safety purposes analyzed in the previous literature. In the manufacturing plant, physical and mechanical hazards are the most common phenomenon. Introduction of visual project management cover this area of concern and explains how to optimize this situation to ensure workers and production safety. According to the research of Juslen and Turner (2005), the control of mechanisms of productivity lighting plays a significant impact and benefits manufacturing environment. They identified that ten mechanisms significantly affected by the lighting changes:

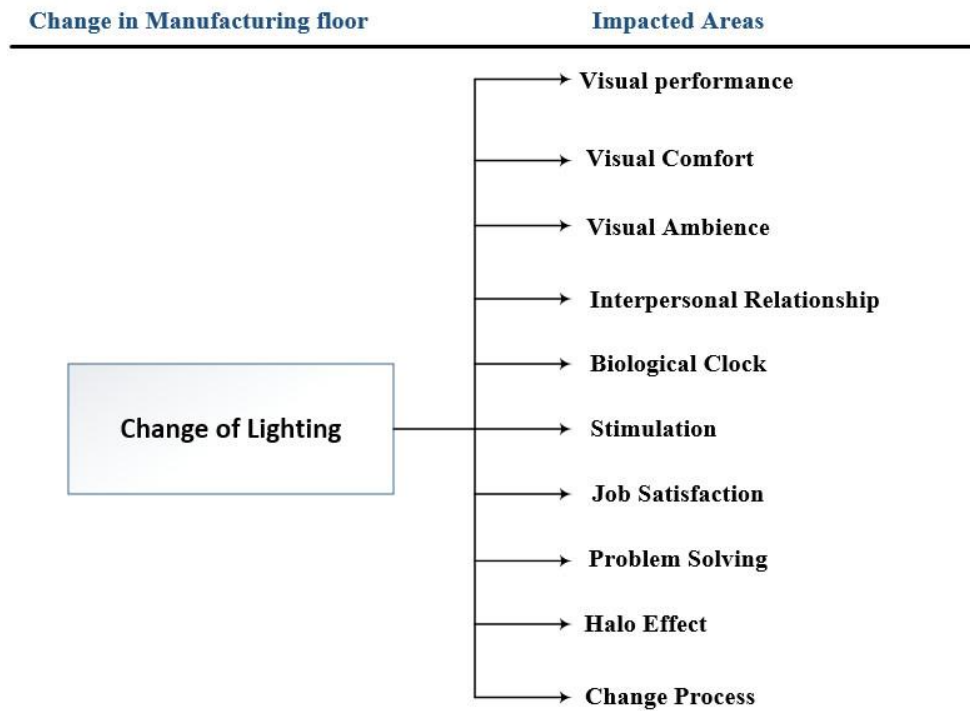


Figure 12: Change affect in manufacturing floor

The manufacturing projects are always focus on maximum profit with the minimal investment of their capital. In a modern sense, they maximize the value creation within a minimum resource consumption (Koren, 2010; Ras et al., 2016). Recently, manufacturers are more concerned about the consumer requirements and value creation niches within production (Rebensdorf et al., 2015). For that reason, industries nowadays are enforced to shorten their production and innovation cycle which ultimately complex their production process (Bauer et al., 2014). This manufacturing attitude portrays the necessity of visual management system incorporated with the modern day's production process. Visual management facilitates improved control and performance in the complex project environment (Kang et al., 2008). The visual management system is undoubtedly useful in the smart production system which emphasizes the increased project outcomes and cost reduction. Moreover, it schedules the project time, track down the progression of the projects and overall execution of the process. Furthermore, in each level of production management, visual management can be implemented and customized according to the process. In essence, this system allows the manufacturing facility to gather their information and available resources from multiple sources and techniques and preserve the historical operations for future projects to develop a smart resource management procedure.

Kattman et al., (2012), utilized the term visualness to maximize the Galsworth's eight building blocks. Visualness is defined as the degree where a factory is eligible to exert

visual controls. However, Kattman et al., (2012) agreed to use the following seven models identified in the manufacturing environment as the guidance of visualness.

Table 6: Seven models for the degree of visualness (Adapted from Kattman et al., 2012)

<b>Models</b>	<b>Description</b>
Kanban	Visual system incorporated with cards or tickets, can be utilized other formats such as colored containers, flow racks, painted floor lines (Steudel and Desruelle, 1992). Favorable in “pull” production system for communicating orders from downstream to upstream workstations and also re-order and restock parts or materials
Call lights	Useful for the operators who regularly required to call for a supervisor, maintenance worker or general worker. Several lights are generally used and each light indicates the different types of assistance (Monden, 1998)
Andon	An indicator board which exhibits when and where worker is instructed to stopped the line. Andon lights are: green, yellow and red which means production is on its flow (green), in jeopardy of staying at rate (yellow) and off rate or having some problems (red)
Digital display panels	Indicates the pace of production and deliver the information about daily production goals and units so far production status. Additionally, customer demand and Takt time often displayed
Visual controls with Poka-yoke device	Known as error or mistake proofing devices consist of detecting instrument, restricting tool or signaling device. Whenever the defects or abnormalities identified this device alert the operator. The aim of this this device is to prevent or detect the mistake that will not hamper

	the manufacturing process
Bordering	Provide explicit indication whenever an item not on its own position. For instance, differentiate the walkways and the working areas, place of storing equipment and identification of minimum or maximum supply levels
Recoil	Capability of an object to memorize of his way back to its designated location relying on the location information. Whenever an item leaves its original position, recoil make sure it will return to its same position. Galsworth for instance describe it as search for fire extinguisher in an easier way within minimum period of time.

However, currently, the understanding of visual management practices has dramatically expanded. The manufacturing companies are keen to implement visual management practices in their projects. Moreover, the utilization of seven models also significantly impacted on the larger scale in the manufacturing areas (Kattman et al., 2012) as compared to the business process areas. Undoubtedly, it was discovered that manufacturing areas enhance their performance employing their productive labor and standardization of their process by implementing visual project management techniques. Additionally, visual management associated with the operation management ensure that the operations of a manufacturing plant are effective and efficient and result in minimum wastage through optimum use of resources (Slack et al., 2010; Stevenson, 2014). Initially, it was experienced that the workers and employees were not comfortable and did not appreciate performing visual workplace practices. When they noticed the time saving and improvement of performance at a great extent, then individuals started to make a connection with the visual practices. Thus, the business process utilizes visual project management in simplistic bordering practices in their general work areas. By contrast, manufacturing plants have numerous complex working areas where the visual management techniques can be entirely implemented. Thus, in conclusion, it can be illustrated that in manufacturing plant the role of visual project management is to control

the production planning, quality of process, safety, operation maintenance, workplace improvement, inventory, human resources, external or internal marketing, and knowledge management efforts.

### **2.3.3 Construction practices**

In the past few decades, the contribution of visual management practices emerged in the manufacturing and service organizations, as it facilitates the employees to know about their roles and participation for their organizational values and customer requirements. However, visual management is not renowned in the construction sector; however, still, the importance of the visualization is significantly recognized in this sector. Moreover, realizing the positive attributes of visual management research in construction areas has extended in recent years (Tezel, 2011).

Designing a construction project is a complex task where several actors and in some cases multiple discipline and organizational boundaries are needed to be connected (Bosch and Henriksson, 2014). Notably, in a construction project, coordinating, information gathering and sharing of knowledge among the involved actors are the key drivers for the success of a project. The previous research has been conducted on visual management in construction sector to explore the concept itself in construction context or either analyzing or explaining the applicability of some visual tools in the construction industry (Brady et al., 2012; Saurin et al., 2008; Kemmer et al., 2006; Formoso et al., 2002). Even though the sharing of information and knowledge is required but in construction project context it is discovered challenging as mentioned in previous studies according to diverse perspective. However, developing a construction project is considered largest segment in the construction industry and the industrial construction associated with the highly technological project is 10% distinctive in its processes, methods and specialized trades (Halpin, 2010). Due to collocation, complexity exists in the construction project, yet most importantly it removes misunderstanding and enhance reliability and nevertheless ensure the quality of the final product. For that reason, collocation has found utilization in the broader extent in the construction industries in terms of BIG Room concept (Liker, 2004), extreme collaboration (Garcia et al., 2004) and integrate concurrent engineering (Evbuomwan & Anumba, 1998). Moreover, those approaches are preferable to utilize in the larger construction projects, where project design teams are focused on a single project. A semi-collocated design team is involved for this collocation process for one or

two days a week and they provide rest of the support from their home offices. Furthermore, the most significant component of this collocation supports is that it will be used for several types of visual means.

The necessity of visual project management also emerged due to the requirement of transparency in construction projects. The earlier discussion by scholars focuses on increasing the process transparency on the construction sites (Koskela, 1992; Dos Santos et al., 1998; Formoso et al., 2002; Heineck et al., 2002). In the construction project. Formoso et al., (2002) study found some crucial elements that hinder the transparency, for instance, numerous inter-dependable production units forwarded to the group of workers who are working in the same area and leaving the units as cluttered and disorganized. As a result, it becomes wastage and loss of materials occur. However, the research conducted by Heineck et al. (2002) abridged that through the visual management process transparency in a construction project can be enhanced in the following way:

- Maintaining clear and orderly visual workplace for better flow of information
- Synchronizing the information with the construction process
- Following the visual system to get notified about the process status
- Obtaining visible site layout
- Enhance the project drawing
- Better sequencing plan to reduce task interdependencies

Moreover, Emmitt et al., (2012), identified the advantages of visual management in construction industries leads to:

- i. Simplify the decision making
- ii. Improve communication in different hierarchical levels
- iii. Decentralize construction policies
- iv. Broaden the employee engagement in construction process
- v. Develop on site coordination and promptly response the identified problems

In the constructions site, different types of visual management tools and techniques can be seen which are generally originated from the manufacturing industry. For example, the material control system "kanban" has been investigated widely and preferred to be

implemented for the construction context (Arbulu et al., 2003; Yu et al., 2009). Therefore, according to the research of Jang and Kim (2007) Kanban system is extensively used for controlling the material and ensuring the safety issues in metro construction projects. Moreover, the anticipation and performance of visual production controls (i.e. kanban system), visual production leveling boards (i.e. heijunka boards) and visual quality signals (i.e. andon system) has created a positive impact on the construction projects (Alves et al. 2009; Barbosa et al. 2013; Emuze and Saurin, 2015). In addition, the visual management systems can also be encouraged to interconnect the Last Planner Systems to organize the project plans incorporated with site teams (Ballard and Howell, 1997; Jang and Kim, 2007; Brady, 2014). Moreover, Tezel et al. (2015) demonstrated a comprehensive taxonomy about implementation characteristics of a visual management strategy for developing construction projects in his research.

Visual management also supports safety management in construction projects. In many developed countries, however, more emphasis is given on the surety of safety regulations and it is monitored on a mandatory basis. Some visual safety devices are essential in any construction projects such as foolproof devices for lift doors. Moreover, the purpose of visual control can be utilized innovatively to explicate the acceptable boundaries through some sets of visual devices, for instance, physical barriers, color coding instructions or sirens, etc (Saurin et al., 2008). Nevertheless, in comparison with the manufacturing industries, the availability of foolproof devices is low in the construction project and additionally, there must be an opportunity to develop more foolproof devices for the construction projects (Tommelein 2008; Saurin et al. 2008).

Despite the growing advantages of visual management in construction projects, Tezel et al. (2016) found some barriers and drivers on their case studies that manipulate the dissemination and further development of visual management in the construction projects. Those sources of barriers and drivers are formed through the highway construction project and are described in table 7:

Table 7: Barriers and drivers of VM in construction project (Adapted from Tezel et al., 2016)

Barriers of Visual Management	Drivers of Visual Management
-------------------------------	------------------------------

Scarcity of proper awareness of VM	Prioritizing the attention to lean construction
Visual visibility of VM (e.g. visual performance boards)	Increasing the number of institution who actively concern of VM in construction projects
Lack of top management support and ownership	Involvement of VM facilitate the contractors to work more efficiently
Lack of communication with operational staff to move VM further	VM enable to reduce operational waste and enhance the coordination
Deficiency of personnel driving of VM and maintain a lean construction in construction projects	Managers can distribute the obligations to their personnel through VM
Lack of business cases for VM	Cooperation with the universities to drive VM in construction projects
More advanced VM required for the complex construction projects	Higher success rate of implementing VM in the construction projects leads to future driver for the contractors
Required proper documentation of training	Ameliorate the employee morality, efficiency, collaboration with supply chain partners and develop indulgence in effective construction ambience
Frequently audit of VM for best practices required	
Limited sharing of transparent information among the contractors	

Nevertheless, through the previous literature, it has been found that despite the growing body of research opportunities, in the construction research community, visual



management is considered as the least preferable research themes (Daniel et al., 2015). The above analysis reveals that visual management in construction projects mostly covers the area of process transparency concept or application of manufacturing based on visual control systems. Liff and Posey (2004) identified that the features of visual management and their opportunities for implementation highly rely on the context. In other sense, due to numerous supply chain participation in the construction projects make these process complex; as a result, the outcomes from visual management strategies and techniques in the manufacturing industry are required to be modified to facilitate the information sharing (Titus and Bröchner, 2005). Furthermore, the role of visual management in the construction section can be greatly influenced by proper studies and research. Most of the researchers emphasize this area of concern. The general understanding of visual management in construction sector based on the conceptual benefit discussions is mostly on strategic qualitative benefits. Therefore, real-life implementation both on the on-site and off-site (office environment) constructions projects need to be observed for a better vigorous understanding of its advantages. Finally, the profound investigation and discussion of the visual management systems incorporated with implementation features and challenges for the construction projects are favorable for the future applications and modifications.

#### **2.3.4 Health care practices**

Public and private healthcare projects are concerned about the pursuit of continuous improvement performance on their service. Specifically, they emphasize to provide a high level of service quality to the citizens in the public health care system and additionally, ensure the dedicated care to the patient with available resources. However, the technologies are advancing drastically in this modern era which ultimately influences the life expectancy of citizens and provide better facilities. For that reason, the cost is increasing and in terms of economic crisis, health care providers find difficulties to afford such facilities. Moreover, the patients will not tolerate the lack of care due to communication deficiencies among the staff and personnel. According to the research of O'Brien, Bassham, and Lewis (2015), the cause of clinical errors occurs due to the communication problems with regards to the patient's condition and the proper care plan. In health care projects, the demand of improving managerial solution emerge due to complexity of processes and expectation of service by the patient. Among all the methodologies the adaptation of visual management system to enhance the quality of

healthcare is significantly notable. According to Puyou et al., (2012) and Bell, Warren, and Schroeder (2014):

*“The term visual management is utilized in some specific disciplines for a broader range of application of a visual frame of reference and as well as incorporated with some visually based research methodologies to alleviate the issues of management and organization”*

However, the practices of visual management are usually connected with process improvement philosophies and specifically with the lean project management systems. Investigating the previous literature reveals that besides some severe infringement (Parry and Turner 2006), there is a noticeable lack of coverage of visual management in the academic literature in operations management and management of healthcare projects (O'Brien, Bassham and Lewis 2015).

The concept of visual management is rapidly spreading in the health care sector. Health care project management have a significant role in health care industry as they facilitate controlling the cost, managing the potential risks and improving the outcomes. Visual management promote the potential contribution of improving the quality of service and attracts the management to utilize it in their process of projects (Costa and Godinho Filho, 2016). Besides enhancing the communication facilities, the anticipation of visual management principally influenced the efficiency and effectiveness of the employees' activities and additionally, ensured the area of safety management. Most of the healthcare projects thought of implementing a lean management system. However, the research of Maan (2010) illustrate that before adopting the lean manufacturing approach daily practice of visual tools and techniques can be useful to establish the lean environment. Therefore, recently, numerous health organizations and hospitals are willing to adopt visual management system in the process to comply with the project management processes as well as expose all the faults and make them visible in the system (Liker, 2004).

There are limited studies conducted on this emerging topic. As a result, it remains underestimated in many cases. Only a few studies cover the concept of visual management in healthcare projects. However, the advantages of visual management tools eliminate most of the unnecessary activities and take preventive measures. Moreover, it

facilitates proper inventory management, reduces the cycle time and most importantly delivers high-quality patient service in a responsive manner (Steed 2012). Złotowska (2018) identified some crucial advantages of visual management tools that comply with the process:

- Demonstrate the activities in a process
- Notify the placement of equipment and storage of materials. For instance beds, x-ray machines, laboratory materials
- Convey simple information to the responsible personnel and patient
- Deploying message signs
- Proper alignment of workspace and stationary tools
- Differentiate the job position with identical colors
- Organize the official documentation
- Ensuring the safety of personnel and patients

Through the empirical research different scholar, emphasize different areas of healthcare for utilization of visual management process. For instance, O'Brien, Bassham, and Lewis (2015) focus on improvement of patient flow and discharge system. Some of the scholars prioritize the task flow management system (Teng et al. 2013). So, the diverse concern influences the cultural change in the hospital. For that reason, it is required to standardize the procedure and the activities. Proper monitoring and maintenance of the visual management system will be beneficial to care for the patients of the hospital. Moreover, in order to control the system through visualization, it is always suggested to update the data on a regular basis which will help the other participant to know the recent status and next objectives. Furthermore, it will motivate the employees to follow the process and perceive the situation effectively. Therefore, visual management provides timely, understandable information to the employees to increase ownership of their assigned work (Poksinska et al., 2013).

## 2.4 Summary of theoretical review

In recent project management practices, key project stakeholders and executives are willing to compress the project time and maintain a compatible quality in the overall process. As a power mode of cognition and memory from the manufacturing to the health care project, visual project management takes the prevalence in both communication and control of projects. However, according to Bilalis et al. (2002) numerous organization nowadays focus on their delivery of information and communication system effectively to ameliorate their workforce. Developing a lean project management ambiance the participation of visual project management tools are the absolute requirement. Champan (2005) found that visual management is base that constitutes the building blocks of lean principal. Moreover, the guidance of the visual management through utilization of the visual tools provide the versatility of managing the projects (Grief, 1991).

The previous literature abridged the diverse application areas of visual controls and mostly emphasized on the role of VM in workplace structuring and orientation. Besides, Galsworth (1997) inaugurated a recipe approach which illustrates the way visual methods should be approached that facilitates any process improvements within the projects. Earlier, from the manufacturing practices of Toyota Production System, the anticipation of visual project management has currently enhanced the manufacturing efficiency by utilizing various visual attributes and tools (Warwood and Knowles, 2004). Moreover, ensuring the safety, transparency, overcoming the barriers, the participation of visual project management and their functions plays a vital role to control the project management strategy.

Throughout the literature review, various visual management functions have been discussed that depicted in some conceptual discussion about the significance of visual management and its tools which are implemented in the diverse required area, for instance, projects process or within the organizational environment. It is an obvious prerequisite to comprehending the functions of various visual tools despite utilizing them directly. Transparency, job facilitation, on the job training, continuous improvement, as well as other functions, facilitate the requirement of the visual project management strategy to control the project performance. Moreover, the incorporation of several tools enables project personnel to utilize different aspects of an application. Kattman et al.

(2012) summarized that visual tools associated with the visual management functions provide essential day-to-day information to the employees to maintain the project effectively. On the other hand, Greif (1991) found that visual tools are integrated and can be exposed openly within the work environment, which enables easy-to-reach and easy-to-see opportunities. However, the framework discussed by Hirano (1995) and Galsworth (2005), enables the opportunity to implement visual tools in any project or workplace. In the framework, the essential combination is with the visual performance centers/ Obeya Rooms, Visual standards and 5S. Several regions of this framework indicate the status of visual management in the workplace. For instance, the upper part stipulates the improved visual workplace that is fulcrum by the several visual and continuous improvement tools, obtained and acquired knowledge. This framework was considered as a possible visual workplace implementation indicator. Moreover, this framework proposes an essential design proposition that facilitates for creating a compelling visual work as well as conciliates the given sets of practical visual aspects. Concerning that, a visual management application framework was proposed by Galsworth (2005) which allows utilizing the visual elements systematically in the various project environments. From bottom to top, each tier demonstrates the attributes of visual elements that constitute visual management workplace. This framework is also crucial for establishing standard visual practices throughout the project. However, in many lean studies, this type of framework for practical implementation of visual management was missing. Furthermore, through the literature analysis, this implementation of the framework has been formed to explore the practical and evaluation of assistance attributes to reflect in the field of visual project management.

In the literature analysis, different visual project management tools have been found that comprehends the complex projects and provide strong backings for the top management at high volumes. Similarly, the definition of visual tools by Galsworth (1997) and Liker (2004) says that the purpose of the visual tools is to evolve the conceptual idea and thought development forms that influence, direct, limit, guarantee or otherwise impact human behavior relative to a specific performance process or outcome. However, some crucial visual project management tools have been discussed that are accessible to rundown in project management practices and control the project. Mind mapping, process mapping, and root cause analysis are some core visual project management tools that can make a significant impact on project performance. Those tools are simple but effective in

finding the hurdle in the ongoing projects, and naturally, deliver the first preventive measures to optimize the problems. However, among the tools, in a noticeable way Nielsen (2009) alludes in his research about the significance of Dr. Kaoru Ishikawa's fishbone diagram that can recognize the problem and suggest the improvement in a plausible manner.

Recently academics and practitioners realize the inevitability of visual management practices to construct projects or organizations that are truly compatible for future (Ghoshal 2005; Johnson and Broms 2000). Exploring the current state of visual project management in the diverse sector like construction, healthcare, manufacturing it is evident that due to an immense number of dynamic information in project management constitute the management of information more critical and complex to control the ongoing process. Moreover, Ware (2005) summarized in his research that, visual management have the competency to explore far more complex concept structure that can be exhibited externally in a visual display which can be notable in both visual and working procedure.

"Project Control" is an essential term in this research associated with visual project management. Nieminen and Lehtonen (2008) believed that the success of a project relies on the efficient control of the project. In the execution phase of the project, project control is considered as a core element. In recent years, the inclusion of visual project management practices assist the streamline of workflows and create indulgence to control projects. The study of Whyte, Ewenstein, Hales, and Tidd (2008) and research of Jaafari (2007) agreed that project control tools ensure a connection between organizations and the employees to enhance the project health. Hence, project control is always taken into account by the project managers so that they can run the project on a specific track and incorporated with the visual project management and hence more feasibility of controlling project has now emerged. In addition, the framework proposed by J. Kivilä, et al. (2017) abridged the involvement of project and visual management relationship directed towards sustainable project outcomes. Those control mechanisms emphasize different performance indicator of visual elements that control the ultimate project sustainability. The majority of the project practices are concerned about control through visual practices. However, the research of J. Kivilä, et al. (2017), reveals the contribution of a project and visual control packages in controlling the project inside and outside the

project organization. For that reason, most scholars prioritize to utilize the visual project management in diverse project activities explicitly enriching the project team performance to accomplish the project aim and targets. Additionally, the involvement of stakeholder's views on project control and collaboration in projects and their goals constituting the visual project management practices are more prominent. Nevertheless, the participation of visual project management in distinct areas will ease the transfer of knowledge across the various functions likely from the stakeholders to professional experts.

Therefore, visual project management enables the project managers to schedule resources correctly which will result in effective and efficient utilization and additionally early identifications of bottlenecks and conflicts. Moreover, through the employment of visual practices project resources can be controlled and governed. However, fostering the cultural improvements and providing transparency of information encouraged the management to carry out independent scrutiny of projects. Additionally, through the implementation of visual project management enable the responsible project personnel to control and monitor both external and internal concerns of projects firmly that could direct towards the project goals.

### **3. RESEARCH METHODOLOGY**

This chapter presents the research design and methodology associated with the data collection and analysis for the empirical study.

#### **3.1 Research design**

The research design plan is considered as a crucial part of conducting the research activities. The explicit research designs and structure is the base for utilizing the data to achieve research goals. Coldwell and Herbst (2004) allude that a proper research design act as a glue which facilitates to combine the research in a well composed rigid shape. Considering the research design as a blueprint Burns and Grove (2003) alludes that research design allows for analyzing various factors in order to validate the research findings. Besides, Polit et al. (2001) defined research design through a testimonial and called it a guide that tests the research questionnaires and hypothesis.

This study focuses on the use of visual project management practices in the case companies to control their projects. The research strategy follows the qualitative nature and relies on multiple case studies. Qualitative case studies are suitable when the research is investigated in the real-life context (Yin, 2017). Similarly, Burns and Grove (2003) agreed that qualitative research is a systematic approach that utilizes the life experiences and real-time scenarios to provide its meaning. However, many scholars and researches like to implement the qualitative techniques to understand the anticipation of people, their experiences as well as their emotions and perspectives. In this study, qualitative approach is involved with collecting the primary data through verbal interaction such as interviews and public materials of their experiences, practices, and participation in the focus research area. The method of collecting data through an interview is employing interpretation and analyzing the perspective of the interviewee. Sometimes it indicates that collecting data is subjective and not always precise. However, the accuracy of the data relies on the participants thinking perspective and researchers own interpretation of the subjective data that they collect.

Nevertheless, the purpose of selecting a qualitative approach is to analyze the practices of case projects and to identify their visual project management practices at a different



stage and strategic level of the project. Through the interview and public documents, the data gathered regarding the visual practices revealed the controlling methods of the project management process. As the collective data is descriptive, so the qualitative approach is the best method to analyze these cases.

### **3.2 Data collection**

Measuring the skills and real-time experience data collection is a typical instrument. Through the individual interviews and analyzing some company reports and materials, the data was collected. In order to gain research goals, visual project management practices are analyzed in two different types of case companies. The reason behind selecting these two case studies was because of their separate project characteristics which allowed understanding more comprehensively about their utilization of visual practices effectively to control and maintain overall project performance. One of the case companies is ANDRITZ Oy, who is leading global suppliers of systems, equipment, and services of pulp and paper industry and other areas like boilers and energy plants. The equipment manufacturing, delivery, and installation processes are complex and are handled by the efficient project management team. In controlling the overall project management activities, the contribution of visual project management practices is highlighted in the interview. Moreover, the role of stakeholders, performance of the project team and mode of utilization of visual elements are also explored through collecting the data. The interview was done via Skype and prior to the interview, the semi-structured list of questions (Appendix-1) was sent to the interviewee. The whole interview was recorded through the audio tape and later transcribed for data analysis. The interview was beneficial to analyze profoundly about the real-time issues and hurdles that could be controlled through visual elements. The cooperation of interviewee allowed getting more information about controlling their project management practices through diverse visual tools and techniques. The Sydney Metro West project data was collected through project reports and publicity materials such as project newsletters, project website, annual reports of past few years, visual amenity reports (2017), and visual impact assessment report (2018). Those reports and materials were instrumental because they delivered the most accurate scenario of the project. As most of the project personnel of Sydney Metro were busy so, no interview was managed. Nevertheless, the information reveals the actual outcomes of the project controlling methods and contribution of visual management

practices to maintain stakeholders, industry and external and internal influences of the project.

Table 8: Summary of the case description

<b>Name of Case Company</b>	<b>Location</b>	<b>Source of Data</b>	<b>Project Scope</b>
ANDRITZ Oy	Varkaus, Finland	Skype Interview	Manufacturing and installation of equipment in customer site
Sydney Metro West	Sydney, Australia	Project report & public materials	Construction of Metro rail project in Western region of Sydney

### 3.3 Data analysis method

The collected data were analyzed through a thematic content method. It focuses on examining, pinpointing and recording the pattern within data (Braun & Clarke, 2006). Based on the prior research, the information was classified and organized into different themes of the project context of the case studies. The collective information from interview and report was categorized by visual project management practices in different stages of project processes. Moreover, information were further analyzed for visual tools identification, project controlling procedures and project status. Categorized data helped to identify project management processes, utilization of visual management practices, visual techniques and control mechanisms and performance of composed visual project environment was validated. Nevertheless, from the information analysis facilitated to compare the outcomes across the two case companies.

## 4. EMPIRICAL STUDY

### 4.1 Case project-1: ANDRITZ Oy

In this section, the background of the esteemed organization “ANDRITZ Oy” is outlined, along with its visual project management practices to control their projects. The background discussed in this section is based on the interview and online materials.

#### 4.1.1 Background

The first case project, i.e., “ANDRITZ Oy,” is one of the leading global suppliers who deliver vast amount of systems, equipment, and services for the pulp and paper industry (AG, 2019). Additionally, they also contribute to wood processing, fiber processing, chemical recovery, stock preparation- as well as biomass boilers, pelleting plants and gasifiers for energy generation. Besides, the other most emerging part of this business includes the supply of engineered, customized and technologically advanced wear and production parts that enhance the overall production efficiency of a customer’s operation. Those attributes are considered as a significant cornerstone of company strategy. The headquarter of the company is located in Helsinki, Finland and has the “centers of excellence” located in Lahti, Kotka, Lappeenranta, Savonlinna, Tampere, and Varkaus (AG, 2019). Currently, ANDRITZ Oy, employees more than 1,300 highly qualified workers currently working in Finland who provide the dedicated performance to help in achieving global market leadership and customer satisfaction (AG, 2019).

Table 9: Products and installation area of ANDRITZ Oy

Products	Area of Installation
Boilers	Pulp Mills
	Evaporation Plant
	Vertical Plant
Power Boilers	Power Production (e.g., Electricity )

ANDRITZ Hydro Oy, a subsidiary of ANDRITZ Oy, are suppliers of electromechanical equipment for hydropower plants. This business area provides the complete range of products which include turbines, generators and additional equipment of all types and sizes. Small to large hydropower plant projects are capable of generating outputs of more than 800 megawatts per turbine unit (AG, 2019). ANDRITZ Hydro Oy has a leading position in the modernization, refurbishment, and up-gradation of the existing hydropower plants. However, pumps that transport water for irrigation of agricultural land, housing and various appliances for diverse industrial purposes like turbo generators for thermal power plants are also assigned to this business area.

Works Oy, a subsidiary of ANDRITZ Oy, provide manufacturing facility and is located in Savonlinna, Finland (AG, 2019). In Works Oy, different vital components, as well as spare and wear parts of ANDRITZ equipment and systems are produced and assembled as well. Moreover, Works Oy supplies machinery, equipment, and services for the worldwide pulp and paper industry. Furthermore, Warkaus Works Oy another subsidiary of ANDRITZ Oy is an engineering based company situated in Varkaus, Finland (AG, 2019). The company supplies the most demanding pressure-bearing components for chemical recovery boilers and power boilers for industrial applications.

ANDRITZ Oy has highly qualified project management team to operate smoothly in diverse cultures around the world. The vision of the project management team is to streamline project execution, optimize operations, and enhance supplier's mill's value generation and develop a win-win relationship between supplier and ANDRITZ. Utilizing different project management tools and techniques the project team provides varieties of project services including front end planning, project engineering scoping, budget estimations, cost analysis, and ROI payback justification. However, ANDRITZs value-oriented and cost-effective approach incorporated with pulp and paper process knowledge, advanced technologies, quality engineering, and hardware provide a complete and tailored solution to the customer.

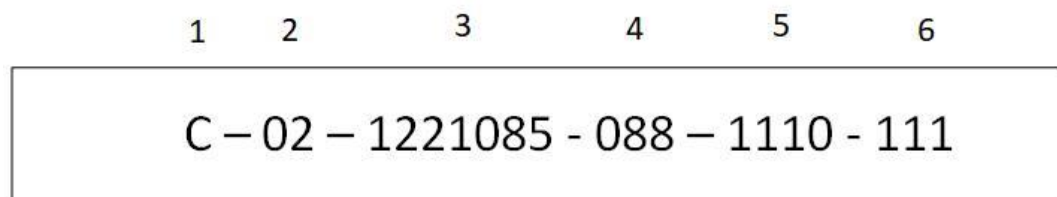
Nevertheless, ANDRITZ is compatible with varying challenges, innovative technology, freedom of planning of individual works, reliability, and integrity of values and core outcomes. Moreover, it creates more opportunities to develop more knowledge and experience with a fast-paced international technology company. The headquarter of

ANDRITZ Group is in Graz, Austria. Over 160 years of experience and 25,600 employees and more than 250 location in over 40 countries around the world, ANDRITZ provide support as a reliable and competent partner to its valuable customers to gain their corporate and sustainable goals (AG, 2019).

**Project Management:** The experienced project management team closely monitors the complex projects of manufacturing and installation of equipment. The project management team led by a project manager provides support throughout the whole implementation period from engineering, planning, and erection until the start of the mills (AG, 2019). Moreover, technical and service support is also readily provided throughout the entire life of the equipment. After signing of a project contract, the actual execution work is then handed over from the sales department to the project management department. The project management team initiates the project with detailed planning by analyzing the schedule. It considers all the technical and commercial issues, for instance, kick-off meeting, design phase, manufacturing time, erection time and payment milestone until the final confirmation and acceptance certificate from the customer. During the entire cycle of the project, the team also focuses on project progress and costs and maintains regular contact with the client.

In project management practices, ANDRITZ follows a Work Breakdown Structure (WBS) to manage and control the project. Work Breakdown Structure (WBS) is a hierarchical and tree structural decomposition of a project. WBS facilitates the teams to work into manageable sections. Once, a project has handed over to the project management team the development of Work Breakdown Structure is initiated with identifying the aims and objective and later subdividing it into components regarding the size and duration of the project and individual responsibility. Those subdividing components are known as systems, subsystems, subtasks, and work packages. However, exerting the WBS, the project team acknowledges the scope of the work to be carried out and creates a pathway to accomplish the project aims and objective. As a result, the project team successfully develops the required deliverables within the scheduled time. Nevertheless, focusing on the primary products of the project WBS support the project team to meet the planned outcomes when the desired projects end.

In Work Breakdown Structure, ANDRITZ generally uses three levels: product level, equipment level and component level (Figure 13). The WBS advances through the system based approach and the component and equipment level are divided physically. Project work is divided depending on the work packages in global numbers. More specific information about the engineering process, the amount of engineering required per equipment is determined. Moreover, adequate cost estimation allows the project team to allocate the budget more precisely to accomplish the project goals within the planned schedule.



1. Letter defines the partner: Client (C) or other division (D)
2. Number of Concern (02= OY, 1= AG)
3. Project Number
4. Product Number (026= Recovery Boiler, 027= Evaporator, 088= Power Boiler)
5. Equipment Level (1110= Heating Surfaces)
6. Component level (111= Furnace Upper and Middle Section With headers)

Figure 13: Example of three-level WBS number code used in ANDRITZ Oy.

While the project progresses, some potential risks or threats can arise and WBS support also helps to identify those threats to control the project. ANDRITZ Oy supports customers with continuous improvement projects to enhance the productive value of the manufacturing plant. The overall cost-effective approach, proper utilization of resources and maintaining the quality of the project is the crucial role of the project management team.

#### 4.1.2 Visual management of ANDRITZ Oy

As mentioned in the literature review, visual management connects the project management systems, workplace elements, work processes, and stakeholders. The

interview revealed that ANDRITZ Oy follows some visual elements and tools for maintaining their project management process. Under the KRP (Power and Recovery) division, the project management team generally implements the visual management practices throughout the project life cycle.

In recent project management practices, visual management processes or elements contribute as a key indicator of project progress, project reporting and analyzing the project status. Throughout the project management phases, ANDRITZ utilizes various visual management processes. Typically, the project starts with engineering. Afterward, some purchasing activities are done. At the same time, engineering is also initiated. When the first phase of manufacturing is moving on, there is a need to start engineering activities as well at the same time. In these phases, visual management assists in generating documents associated with project scheduling and visual dashboard tools. Visual management develops the project time frame and notifies the team about the upcoming events of the project. However, projects are somewhat complicated due to the involvement of multiple parallel project activities and long lists of suppliers. As a result, during the initial stage of the project, the crucial role of visual management is to develop an active communication network in the project management activities.

Visualization of the project information is one of the essential parts of the visual management process. Documents, for instance, a purchase order from the customer, engineering activities for manufacturing, provide core information about the project activities from where the visualization of the information is developed. Visual management helps in notifying the discipline engineering, procurement, manufacturing, and logistics department about their planned and actual progress of their project. Moreover, they use a project time schedule i.e., Microsoft project which visualizes the project plan and timeframe. Despite having multiple project activities, ANDRITZ requires to visualize all its project related information and show it to the project team members and the top management as well as. However, the involvement of numerous activities and resources in a project creates difficulties to identify the problems and generating, evaluating and execution of alternatives.

The interview with former project manager and current quality manager of ANDRITZ Oy revealed, all of their activities from the beginning of the project to the end which

controls and maintain the time schedule. They gather core information that visualizes through time scheduling starts with the following activities:

- Purchase order provides the information of the estimated time completing the project, quality requirements for the project activities, treatment of the processes.
- Project manager sends the engineering documents to the customer where time manufacturing of equipment's, specifications, process flow etc. is generally mentioned.
- Manufacturing documents deliver the information about the estimated time of manufacturing, material and tools required for production, equipment specification, parameters etc.
- Supplier quotation reveals the cost of production, delivery time, quality of the equipment and mode of delivering goods.
- Final confirmation to the customer exhibits all the information to accomplish the project successfully.

As ANDRITZ Oy have only a few internal manufacturing facilities; as a result, most of the time, they have to order the equipment from the suppliers. All the steps are recorded in the time schedule, and the progress of the project is visualized as purchasing activity, engineering activities, logistics activities and so on. The overall process of the project visual scheduling of activities of ANDRITZ is shown in figure 14.



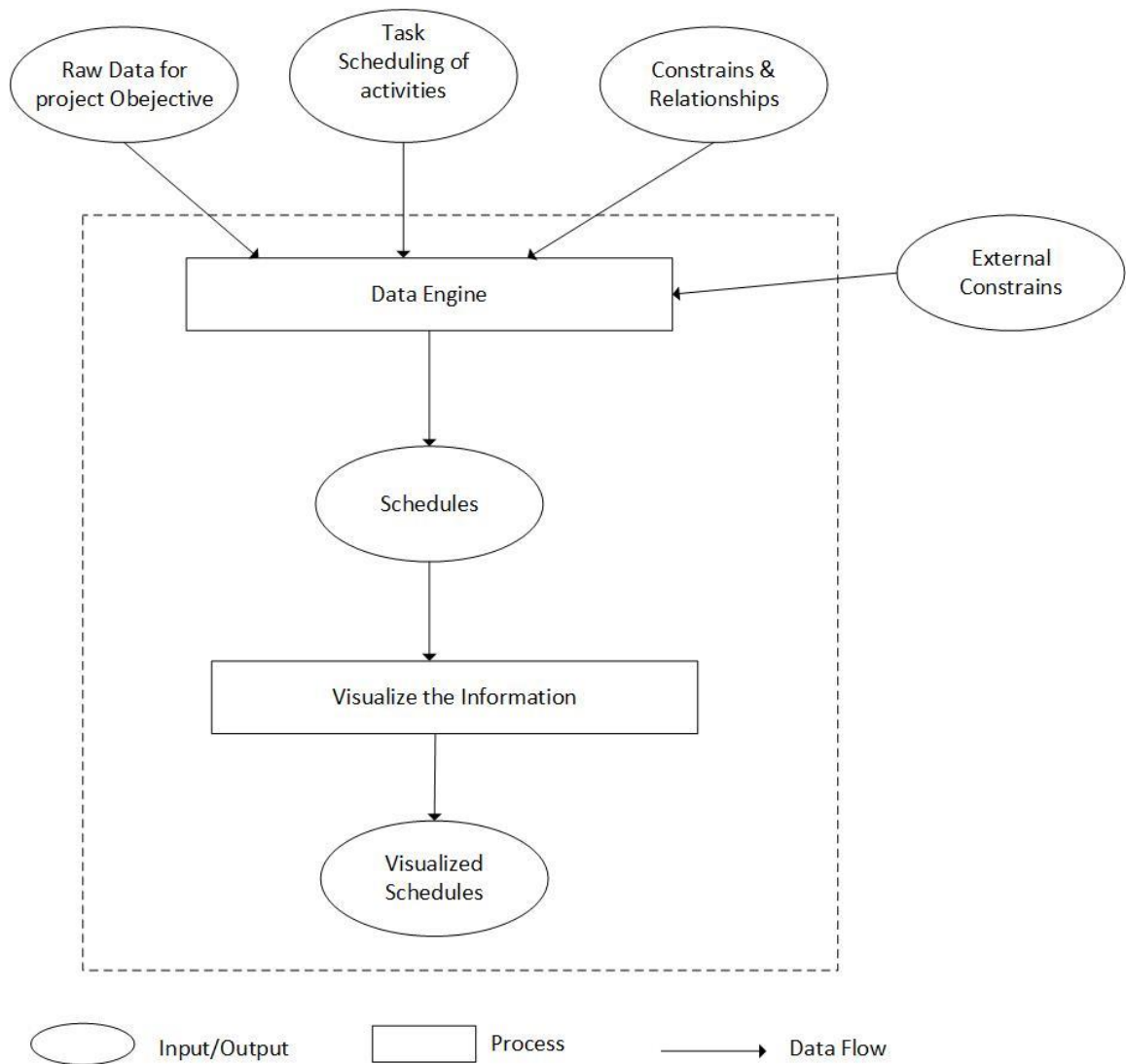


Figure 14: Schedule visualization process of ANDRITZ Oy

#### 4.1.3 Contribution of visual management tools

There is no specific visual tool utilized for the visual practices in ANDRITZ project management processes. The interview revealed that ANDRITZ used to utilize common standard tools for their project management and control processes. Microsoft Project assists for project scheduling, and Excel represents the dashboard of project status. However, there is one significant tool that they follow to identify the root cause of the issues. Figure: 15 exhibits the process of identifying issues within the project. To visualize the causes in the process, the project team utilize “5-Whys” techniques and in some cases use “fish-bone” diagram to visualize the cause and effect analysis.

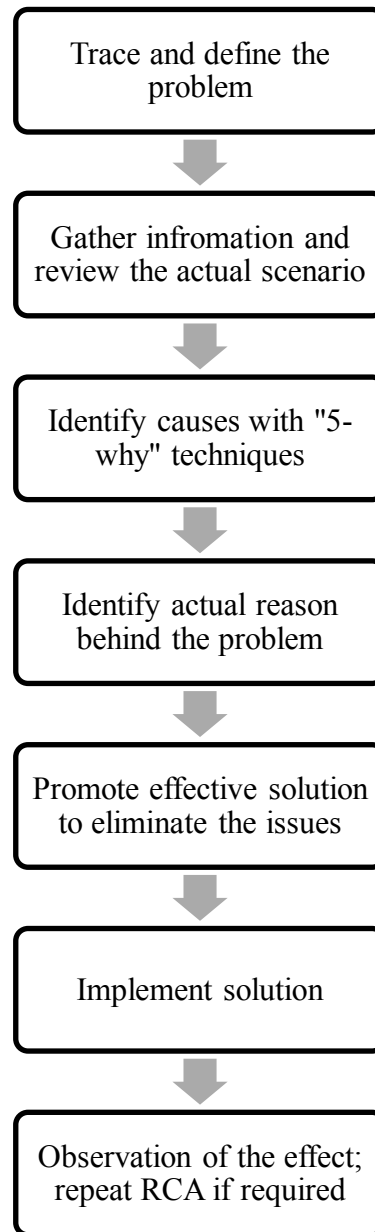


Figure 15: Root cause analysis steps of ANDRITZ Oy

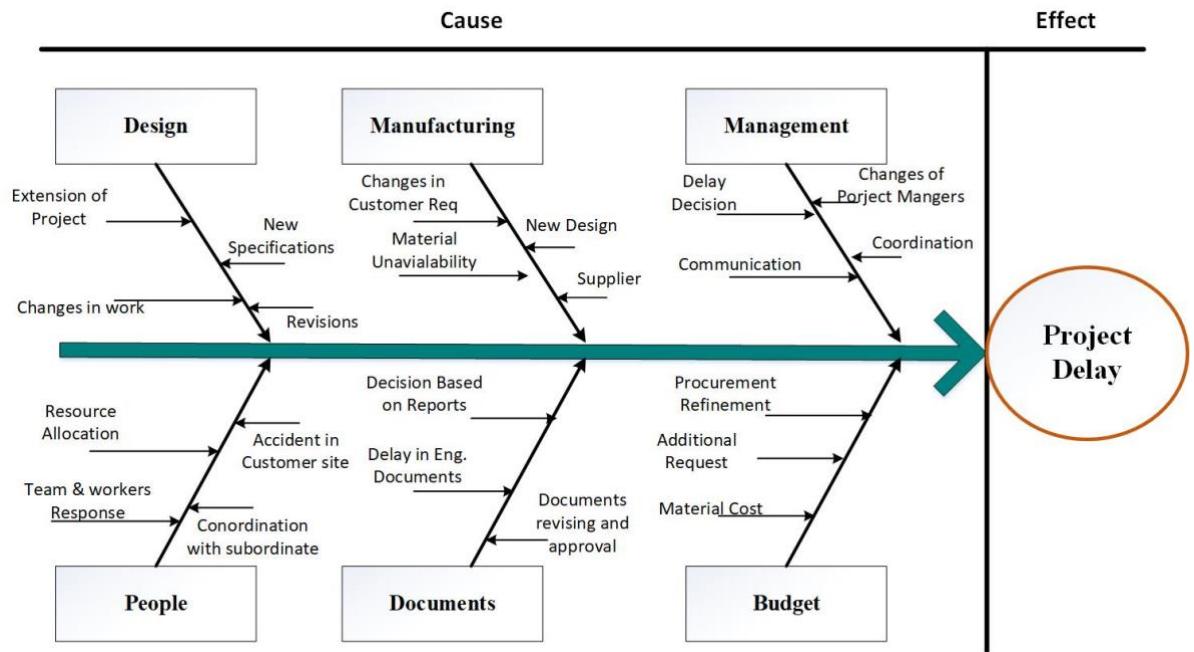


Figure 16: Fishbone diagram of ANDRITZ Oy

In ANDRITZ, fishbone diagram captures the links and relationship behind the potential causes and visualize it in the form of a diagram. Identifying the reason for project delay or any possible threat occurs within the project; the team also get informed every possible reason behind the problem. As a result, the manager gets involved in-depth analysis for presenting the potential solutions of the problem. According to their practice, they mostly utilize the root cause analysis in case of identifying the reason behind project delay. It is described as below:

- a. Limited personnel: In the organization structure, the manager not only perform in one project but also several projects at the same time. As a result, the communication between subordinate or team sometimes interrupt. Moreover, uneven distribution of responsibilities among employees, low workers response in manufacturing plant, accident in equipment installation site are some potential reason to slow down the project.
- b. Documentation: In the project management process, ANDRITZ maintains a large amount of documentation throughout each stage of the project. Delay in preparing engineering documents is the significant flaws that affect the other processes. Moreover, decision-based on project reports, reviewing and approval of requirements consume more time that ultimately influences the delay in the project.

c. **Changes in Design and Manufacturing:** While in the ongoing project, in some cases, customer changes the specification or design of the equipment and ANDRITZ need to anticipate the changes. Therefore, they have to extend the deadline of the project or refine their procurement and engineering activities once again, and that causes the delay in other project activities. Also, consideration of design changes sometimes enforces to purchase new material for manufacturing and check the availability of materials. Those reworks cause a delay in project delivery and completion.

d. **Management and Budget:** Some evidence indicates that changes in responsible person in ANDRITZ slow down the pace of the project. As the new manager requires some time to adjust with the responsibilities and understand the practices. Moreover, lack of anticipation in quick decision making and uneven combination with the team consider the significant reason of project delay. Additionally, frequent changes in project budget depending on the procurement activities, sudden changes in material and production cost enforce the management of ANDRITZ to changes in the budget. Therefore, the project manager re-shuffle the project activities and extended the timeline of the project.

Responsible project managers prefer to implement it when the progress of the project fall behind the actual trend. Asking the questions “whys” several time until each stage of the potential cause has been identified and prioritize it with the relevant causes based on the solution characteristics. The outcomes of the root cause analysis contribute to mitigate the potential flaws and develop problem-solving opportunities in any situations. Nevertheless, to find the best possible solution to the cause’s fishbone diagram keep the project team of ANDRITZ focused and propose solving methods to achieve common goals. Therefore, the anticipation of root cause analysis ensures the project team to optimize the wasting energy and restrict the non-existing problems.

The project team collects the health and safety statistics to measure the unexpected incidents and accidents that happened during the installation period of equipment on the customer site. Based on the statistics, the project team develops a report and a monthly review of health and safety report reduce accident rate and enable workers to take any precautionary steps for future purposes. The report shows only the information about the area of improvement to reduce the accidents but ANDRITZ does not visualize this information on their visual management practices. Even though ANDRITZ is always

concerned about ensuring safety in the installation of equipment but visualizing the information will add more advantages to their project management processes. Nevertheless, any unexpected accidents in the installation site slowdown or some cases break down the overall flow of the project chain. For that reason, the inclusion of visual elements throughout the implementation and rundown period of equipment allows the project management team to maintain control and the project progresses smoothly.

#### **4.1.4 Application of visual management**

Project team focuses on continuous improvement of the project through the continuous monitor and systematically organize project activities. In some cases, different lean techniques come into play. Engineering, purchasing, logistics activities are shown to the top management and as well as the stakeholders in the form of a report. The standard procedural steps of project progress incorporated with some typical tools allow developing active project management environment. Moreover, transparent project environment of ANDRITZ, show the project status to all the members and respective departments involved in the project. As a result, some cases, it creates a decision-making process accessible for the project manager and top management. Furthermore, synchronizing the tasks and analyzing the variance of the planned task with the actual task by drawing the baseline S- curve also supports the project team to mitigate the unavoidable situation and risks factors of complex projects such as manufacturing of equipment in pulp and paper industry. Nevertheless, the project team often face difficulties to introduce the mistake-proof environment in the customer site or on their manufacturing site, but some statement of ANDRITZs suggests of imposing a physical mistake-proofing system to achieve the actual outcome.

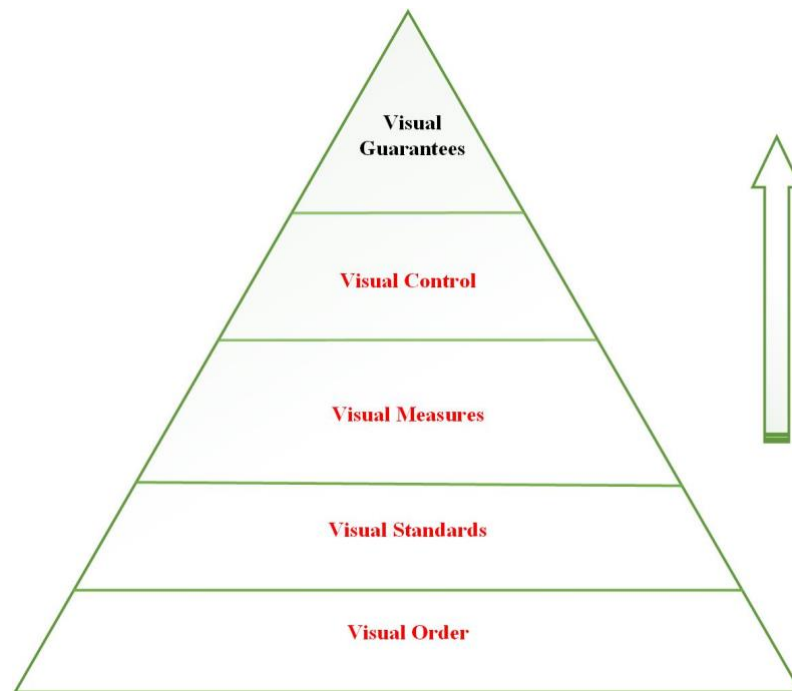


Figure 17: Galsworth's (2005) VM application framework (Characteristics of ANDRITZ Oy highlighted in red)

This framework of Galsworth (2005) represents the role of visual elements to constitute a visual management environment that could be implemented within the project. The role of visual elements in ANDRITZ Oy are as follows:

- a. ANDRITZ has several project management activities and some of the activities run simultaneously. After handing over the project from the sales team to the project management team, project management begins with a systematic orientation of processes. Relying on the customer requirements and supplier response, project scheduling tools helps to organize the project management processes visually. This facilitates the project team to understand their upcoming events and way of maintaining the project smoothly. Moreover, visually demonstrating the processes facilitates to developing proper planning for the project while considering the previous track records and accomplish the project within the given timeframe.
- b. In the next level, visual standards ensure the standardization of the project communication within the team members and stakeholders of the project. ANDTRIZs project management starts with the engineering activities, then

purchasing, manufacturing, quality management, and logistics and so on. As a result, the information and update of each of these steps are shown to the project manager and management. Visual tools (e.g., Microsoft project, excel dashboard) develop the standard visual communication mode and procedures within the organization. So the members of the project always get updated about their project changes, requirements, deficiencies or any other hindrances. However, stakeholder on this level possesses a significant role, because ANDRITZ needs to communicate with both with the supplier and customer several times for revision and confirmation of purchase order and other information regarding the project. They follow the typical method of communication, i.e., by sending reports or verbal communication methods. Additionally, this level allows the team members to access the information about the project and contribute to the decision-making processes.

- c. Afterward, the visual measures ensure the transparency among the project environment and measure the general performance of the project. The information about the project is explicitly visible to all the members involved within the project, but for measuring the performance of the project, there are no specific visual measures employed that evaluate the performance of the project.
- d. The control of the project heavily relies on effective decision-making systems. Project manager often needs to take quick and vital decisions to control the project. Visually displayed the status of the project assist the project manager to make effective decisions. However, the overall project is monitored by a few tools so that control of the project so in most cases depend on the response from the customer or supplier end. However, the positive mark is that visual control supports the project managers to make earlier decisions based on the condition of the project.
- e. The application of visual guarantees leads to the mistake-proof project environment. However, throughout the project management processes, the practical use of visual guarantees is not identified. This element mostly supports the manufacturing environment and the project team often found difficulties to use this kind of techniques in the customer site and manufacturing environment.

Nevertheless, according to the framework of Galsworth (2005), it can be concluded that most of the characteristics of visual management are practiced by ANDRITZ to maintain their project. This leads towards a useful project controlling system. Although there are

more factors required apart from the framework, to declare visual management practices composed one, eventually these are the most impactful characteristics of visual management.

However, the overall characteristics of visual management elements towards project success are abridged below:

Table 10: Summary of visual elements characteristics in ANDRITZ Oy

<b>VM elements</b>	<b>Role in Project</b>
Visual Order	Systematically organizes essential project activities. Relying on customer requirements and supplier response. Support the planning to estimate the date of project completion
Visual Standards	Established standard visual communication within the project management team, customers and suppliers are not involved in this visual communication system
Visual Measures	Ensure transparency of the information so that all the members of the team updated with the project status. Measurement of project performance does not rely on the visual measures
Visual Control	Support effective decision making and whenever the project activities performed inside Finland. Response from the customers or suppliers end, influence the decision-making process
Visual Guarantees	No particular evidence is shown. As the suppliers do most of the manufacturing activities



Based on the above characteristics the level of significance of visual elements in ANDRITZ Oy can be summarized in the below table:11. The elements which have a higher role in project scored as “3”, moderate scored as “2,” and lower role is scored as “1”.

Table 11: Level of significance of VM elements in ANDRITZ Oy

<b>Visual Management Elements</b>	<b>Level of Significance in Project (Score)</b>
Visual Order	3
Visual Standards	2
Visual Measures	2
Visual Controls	2
Visual Guarantees	1

#### **4.1.5 Visual and PM relationship in controlling project**

Controlling the project is considered as a core part of the project execution phase. Achieving the specific project goals ANDRITZ emphasize the control of their project activities from the beginning to closure. Most of the literature indicates that control of projects associated with visual management leads towards the sustainability of project goals and techniques. Controlling ANDRITZ project management processes, the team always focus on the following factors:

- Engineering Activities
- Purchasing and Manufacturing
- Health and Safety
- Quality Management
- Resource Management
- Cost Estimation
- Budget Control

Considering the above factors, the relationship of visual management and project management activities allows the project manager to control the project processes. In addition, the interviewee stated that most of the projects are complex and follow multiple and complex steps from the beginning to the end of the project. For that reason, ANDRITZ always requires to control their overall processes. Interviewee also added that the most vital part of their project management process is engineering. All other activities, for instance, purchasing, logistics and so on are connected with the engineering activities. ANDRITZ utilize a diverse combination of visual management with project management activities depending on project characteristics and complexity. Control and diagnostics mechanisms like plans, budget, resource allocation, schedules, performance measurement, and the report are done through visual tools and techniques.

Analyzing the project characteristics of ANDRITZ Oy, the framework of J. Kivilä, et al. (2017) demonstrated that the combination of visual management and project management activities create possibilities to control diverse project activities that are directed towards project goals.

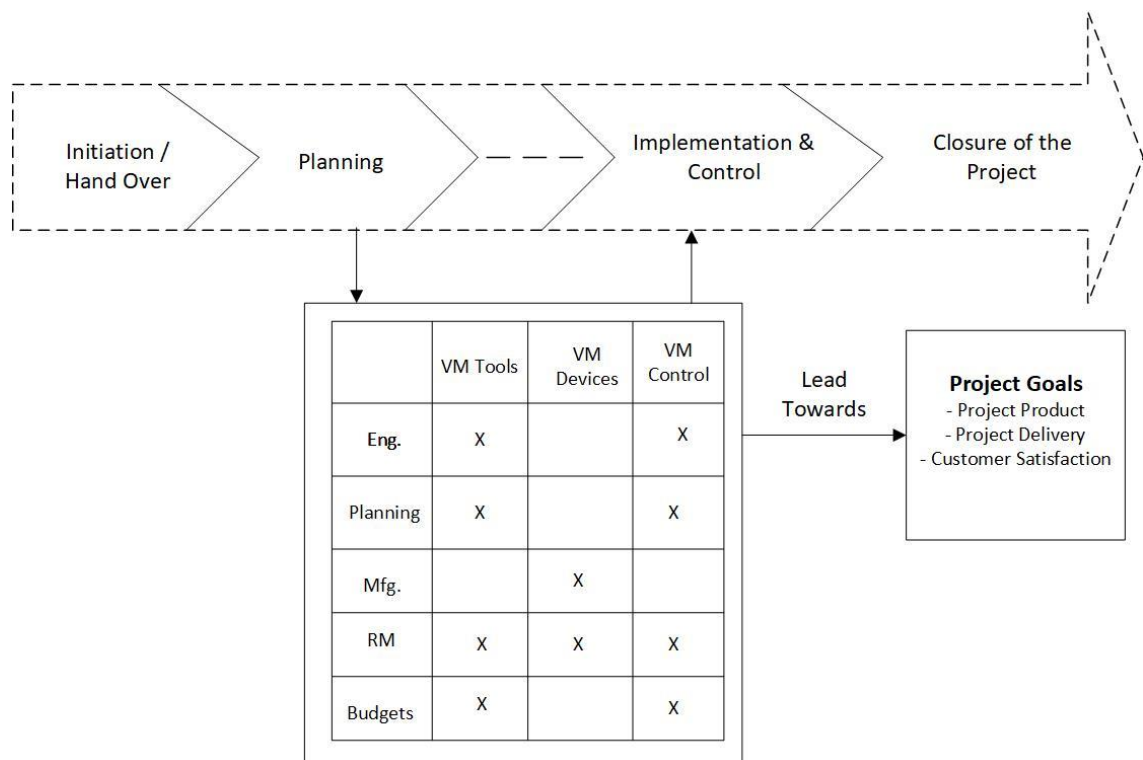


Figure 18: VM in different activities of PM to control project (for Andritz Oy)

This framework reveals the connection between visual management and ANDRITZs different project management activities. Since, the interviewee stated that after the

handover of the project from the sales department, the project is initiated at the engineering department. The participation of visual activities allows team members to find out the issues and status of engineering. Generally, the visual dashboard facilitates the update and visual control techniques to provide effective decision making support for the managers. Moreover, root causes analysis helps to identify the cause of potential threats or delays that create hindrances in other stages. Based on the visual output from the dashboard, decisions are taken with regards to the project situation to control the engineering packages. Because of delay occurring in the engineering phase, there is a high probability of other processes being affected for instance purchasing or manufacturing of equipment. However, in the planned project execution, the delivery date is determined after the engineering activities. Project scheduling tools estimate the probable date of project completion and delivery date. Moreover, all the members of the project are notified of the upcoming project execution date and events where they need to participate. In addition, visual control allows the managers to anticipate a quick change of events. In some cases, due to laggings of delivery of equipment from supplier effects the planning process and later project execution activities. So, the manager refines the project planning and inform it the customer about the redefined planning schedule.

ANDRITZ cover most of the manufacturing processes from external suppliers. ANDRITZ has extensive suppliers network, and most convenient and available suppliers are engaged for the manufacturing of equipment. To control the manufacturing activities ANDRITZ uses different visual devices in their own manufacturing plant like visual indicators, signs, signal influence the human behavior on their production site. So, the employees are always aware of the project timeline and estimated deadline for the production of equipment. Visual indicator sends the signal to the production manager about the production status and it is ultimately forwarded to the project manager. However, for the supplier's activity and their manufacturing progress, ANDRITZ generally relies on the verbal report and visual management barely seen on their practices.

Managing quality, safety, and risks is the prime concern of ANDRTIZs project management process. Lack of quality in the purchasing phase effects the manufacturing site and fulfillment of the customer requirements. Visual tools for instance project dashboard provides explicit indications of purchasing requirement so that the manufacturing process can run smoothly. It reduces the potential threat of diversion of

equipment production. Moreover, as mentioned earlier, for mitigating the risks in manufacturing sector visual devices (e.g. electromechanical device) play a vital role. In addition, throughout the installation of equipment, visual signs or signal also assist the successful equipment installation. Some risks are unpredictable and in that case, management requires to anticipate promptly on the basis of visual notification of dashboard, for instance, increasing of material cost, production failure, installation hurdles, etc. Furthermore, controlling the quality of deliverable products ensure the quality of the overall project implementation phase. All the required visual practices come into play in identifying and mitigating the risk during the project implementation and controlling stage which directs towards successful project execution phase. Nevertheless, the project is required to be completed in the allocated budget. Cost overruns overestimated budget, changes in equipment specification sometimes cross the budget limit. Visualization of the project dashboard is updated based on any changes that happen within the project and allows the top management to reallocate their budget. Despite having a dependency on the verbal reports, in case of any quick decision-making steps, project management team prefer to utilize the visual management practices.

Nevertheless, the participation of visual management results in continuous project improvement that directs the project activities towards the successful completion. According to the interviewee, “Visual management supports the project activities by providing the information about project goals, the status of coming activities and previous records that directs the project towards successful completion of the project.” Furthermore, applying this framework clearly indicates the positive contribution of visual management within the project management practices of ANDRITZ. Therefore, extensive utilization of visual management throughout the whole project management processes promote more controlling of projects and improvement of performance of project activities.

Thus, analyzing the above characteristics of the ANDRITZ Oy project practices, the functions of visual management is summarized in the table below:

Table 12: Functions of visual management in ANDRITZ Oy

Functions of VM	Project Practices	Actual Outcome
Transparency	Explicitly visualizes the information for the project team member; stakeholders receive information in the form of reports.	Team members always notify about project status, improve effectiveness in the project, simplify the project maintenance and monitor system as well as support the decision making and responsiveness
Discipline	Systematically organize project activities associated with scheduling processes and monitor the overall activities.	Facilitate to established standard procedural steps for smooth project management lifecycle.
Continuous improvement	Ensure the improvement facility continuously based on the project feedback and output reports; not familiar throughout the organization-wide practices due to lack of involvement of VM broadly.	Maximize the project outcomes within the internal project management process, not the supplier ends
Job facilitation	Facilitate the employees through notifying the upcoming task for the project	Ease of employees and prepare for planning to handle the upcoming task
On-the-job training	Barely utilize or missing to facilitate this function. Team members are hired based on	Without knowing the significance of visual management sometimes lags the project

	their previous experience	progression.
Creating shared ownership	Stakeholders typically not physiologically tied up for the project goals as VM is not integrated between ANDRITZ and other stakeholders	Cannot afford to control the production facilities and to understand the requirements on the customer end
Management-by-facts	All the facts and statistics are not utilized within VM, for instance, health and safety statistics. Recorded previous data exhibits for comparison with the current project context	Lack of visualization of facts results in biased information. In some cases, VM allows identifying the variation compared with the previous data.
Simplification	Visual management efforts ease of decision-making processes through simplifying complex and quick response to change requirements from customer and suppliers	Reduce the time of decision making and establish strategic planning capacity
Unification	As VM is not utilized throughout the organization-wide, so the synchronization and harmony of management layers regarding the project are not present.	Top management cannot be able to notify the update of the project regularly. They wait for the weekly reports and in some cases monthly reports.

## **4.2 Case project 2: Sydney Metro West, Australia**

In this section, the background of the esteemed organization “Sydney Metro, Australia” is outlined, along with its visual project management practices to control their mega project activities. The background discussed in this section is based on the report and online materials.

### **4.2.1 Background**

Mass transit services are a core portion of growing international cities. Sydney is considered as the most growing city in terms of population, economic, job location and geographical perspective. The website of Sydney Metro reveals that for dealing with the vast population and their transportation facilities, the NewSouthWales (NSW) government has launched a Metro project to connect with different locations of Sydney. Sydney Metro is Australia’s most significant public transport project. This new independent railway will convey 31 metro stations and over 66 kilometers of new metro rail that will create a revolution in Australia’s most significant city travels. Moreover, Sydney metro is also extended into the central business district (CBD) of Parramatta where the rail starts from the Northwest region under Sydney Harbour by constructing underground stations in the CBD and also connecting southwest (Sydney Metro, 2019).

This enormous project facilitates to transport passengers after every two minutes within the city in both ways which the citizens of Sydney has never seen before. The project aims to transport 40,000 customers per hour similar to the other metro systems across the world. However, Sydney's current suburban systems are capable of taking 24,000 people an hour per line (Sydney Metro, 2019). Furthermore, the advanced level of signaling and infrastructure facilities organized through modern project management and governing philosophy enable the metro project to increase the capacity of services entering the Sydney CBD to other regions. Nevertheless, this will raise the services facility to 60 percent to meet the demand. The overall project is categorized in three stages.

Stage 1: Sydney Metro Northwest

Stage 2: Sydney Metro City and Southwest

### Stage 3: Sydney Metro West

New South Wales (NSW) announced the extension of the metro project and called it the Sydney Metro West Project. It is considered as the next underground metro railway which was announced in November 2016. This project connects Paramatta, and Central Business District (CBD) and NSW government are expecting that the investment behind the infrastructure of constructing the Sydney Metro West Project will result in doubling the rail capacity of these two areas. Additionally, the aims are to create employment opportunity, linking with new communities and unlocking housing supply between the two CBDs.

This project will support the significant environs of Westmead, Greater Parramatta, Sydney Olympic Park, The Bays Precinct and the Sydney CBD. Due to a diverse community and rapid industrial revolution, each of these areas bears significance in Australia's economy. For instance, Westmead is renowned for health, education, research, and training in Australia. On the other hand, in Parramatta, the number of employment opportunities is expected to double in the coming 20 years. Similarly, more than 23,000 residents and 34,000 more jobs will be created in Sydney Olympic Park. Besides, 95 hectares of land is used for an innovation hub in Bays Precinct (Sydney Metro, 2019). Finally, CBD allows secure public transportation network and connects with the first two stages of the Sydney Metro project. The station of these areas is now under construction phase.

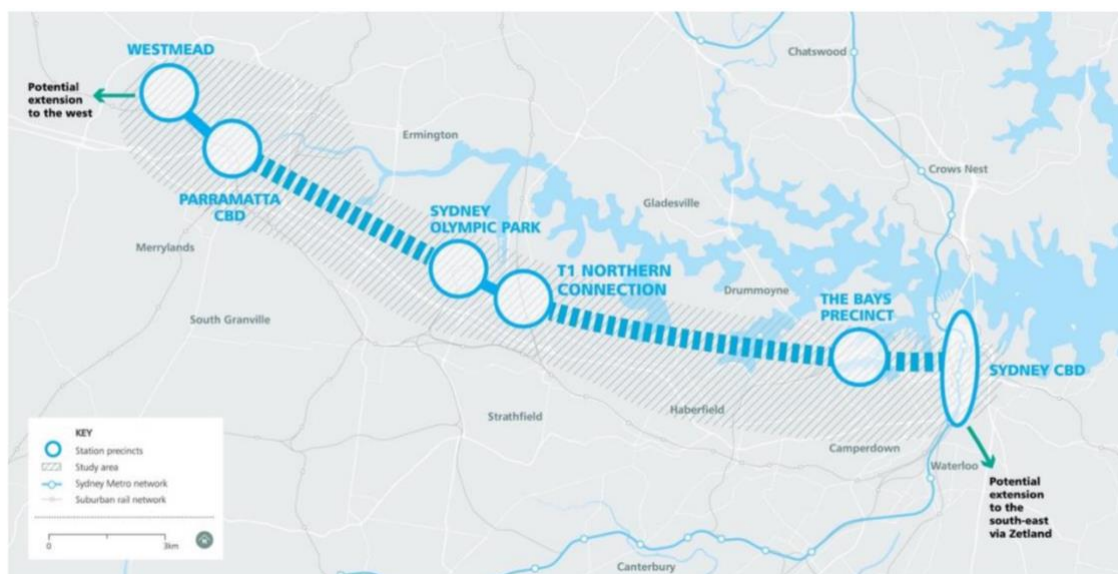


Figure 19: Sydney Metro West project route plan (Retrieve from Sydney Metro Website)



In the recent budget of 2018-2019, the New South Wales government allocated USD 3 billion for Sydney Metro West project. Eventually, the purpose of the budget is for designing the new metro stations, analyzing the best possible outcomes for the customers and communities and the approval of planning issues. Before this recent budget, in 2018 the government invested USD 28 million to accelerate the project so that it can rapidly move on to the next stage. However, initially, the estimated project cost was USD 10 billion. Nevertheless, the NSW government emphasizes and prioritizes this mass transit extension project according to State Infrastructure Strategy 2018-2038.

**Project Management Stages:** The new underground Sydney Metro West railway project connects the communities between CBDs of Parramatta and Sydney that have been previously serviced by railway. The complex project ensures a convenient and reliable journey for the citizens that reduce travel time and reveal diverse opportunities. The project is expected to open in the second half of the 2020s.

Sydney Metro West has a project team which is led by a project director. The project director is responsible for delivering the project outcome and implementation of project activities within the allocated budget restrictions. The experience and learnings of other Sydney Metro Program will motivate the project team for constructing the Sydney Metro West project in a more robust and planned way so that proper resources and stakeholders engagement is possible. However, the project team is also involved in other programs that include:

- Location identification and Project Development
- Finance and estimation of the investment required
- Customer and Project Operations
- Safety concern, Project sustainability and Environmental issues
- Business Operations
- Communication, Stakeholders and Resource Engagement

In Sydney Metro West project, each program has teams and teams reported to the director of the project. The Chief Executive is informed about the project status from the director and who is assisted by the subproject teams. The project standards are established by the chief executive, project director, and subproject teams who additionally maintain the consistency of the project and overall outcomes.

The project development of Sydney Metro West is going on with the following key stages:



Figure 20: Project management stages of Sydney Metro West (Retell from Sydney Metro West Report, March 2018)

In every stage of the project, Sydney Metro integrate the community consultation since 2011 to refine the program with better outcomes. The community consultation was initiated for Sydney Metro West on 27th June and due to a strong response from the community and stakeholders, it was extended until September 2017 (Sydney Metro West, 2019). The experienced subject matter experts of the project team gather all required information for the strategic assessment. Before the investment, the stakeholder and community proposed some improvement to refine the project. The NSW government considers the proposed improvement and then allocate the budget. In the procurement stage, the project team finalize the required equipment, materials, machines and so on to initiate their project according to the planning. Eventually, from the planning to delivery stage, the Sydney Metro Delivery Office within Transport for NSW simultaneously contacts the community and stakeholder for their feedback. As a result, the project team believes that the best possible outcomes can be delivered. Throughout the stages, the project team emphasizes the proper project execution and define activities to satisfy communities.

#### 4.2.2 Visual management of Sydney Metro West

The project team of Sydney Metro West is expected to start the operation in the second half of the 2020s. A significant portion of this project is to build railway tracks underground and the project management team utilize visual management since the initiation of the project. The participation of visual management in this metro rail project is through informing the project progress, performance indicator, generating the progress report and establish reliable communication with the key stakeholders and team members. From the strategic assessment to the project development phase visual elements and several visual tools are utilized to deliver the status and update of the project to Chief

Executive and the director of the project (Sydney Metro West, 2019). Visualization enables the project team and other community and stakeholders to pull the necessary information in a self-service manner. Moreover, in the complex project like Sydney Metro West, visualization reduces information deficiencies well ahead of time of planning which assists in the proper execution of the project activities. Furthermore, information displays the project site, helps to integrate the processes elements like space requirement, machinery, equipment, materials, components, gadgets, and tools. The project management plan ensures the inclusion of all other essential activities for the project. For that reason, the visual information is delivered to the different departments and responsible personnel of the diverse activities of the project. Prior to the project, time schedule and mind mapping have done. The information generated through the schedule and process mapping is delivered to the other departments which are involved in the project management plan. Relying on this crucial information of the project; risk management, safety assurance, project quality plan, design and construction plan and different other plans are made. The Following figure depicts the overall project management plan where the visual information is delivered to control the project.

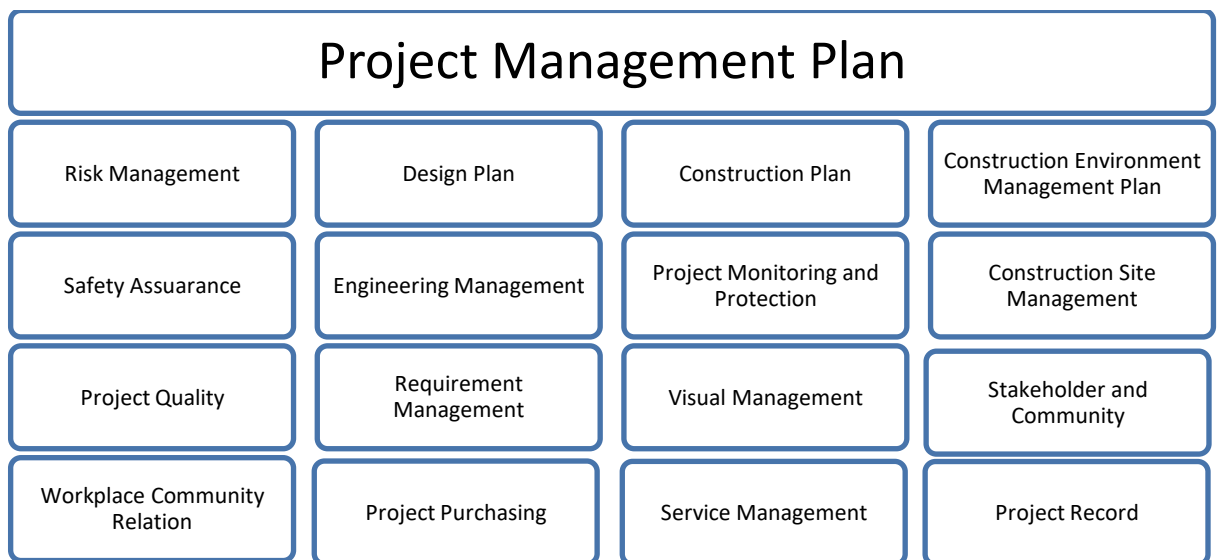


Figure 21: Project management plan of Sydney Metro West (Sydney Metro West, 2019)

### 4.2.3 The contribution of visual management tool

In Sydney Metro West project, the participation of visual management tool cooperates to organize project activities and develop a work frame. The visual impact assesment report (2018) stated that learning from the previous metro projects; the project team is concerned about organizing the project activities prior to the implementation phase. Developing a vital portion of the project underground and redefining of the budget a couple of times makes the project more complicated. Reports from the Sydney Metro West project does not reveal much information about the visual management tools they utilize within the project. However, at the initial phase of the project, mind mapping is extensively utilized to specify the project goals and objectives and furthermore "to do" list. This mode of diagram outlines their project information and steps visually within the organization. Figure:22 exhibits the initial mind mapping of project steps before the project implementation phase:

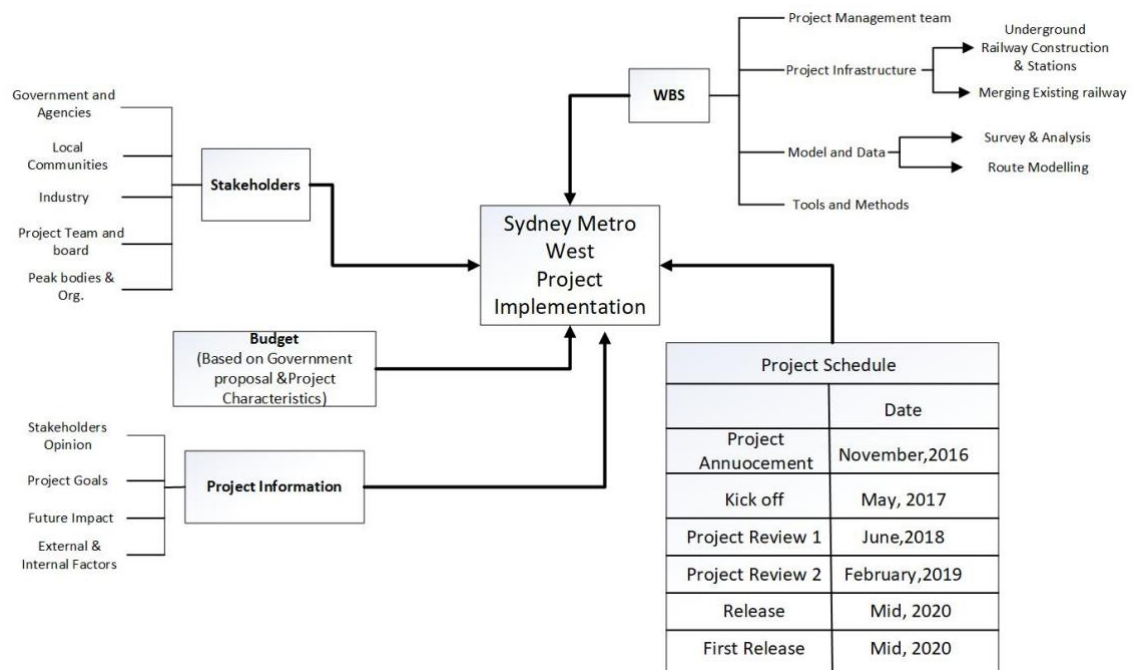


Figure 22: Mind mapping of Sydney Metro West project

Mind mapping promotes the connecting of the facts and information and allows the project management team to organize their project activities visually. The experienced project team gathers their project related information from community consultation, stakeholders opinion or by considering factors affecting the project externally or

internally. Moreover, general construction projects are complex in nature and multiple project activities are involved at the same time so, mind mapping allows the project manager to distribute the responsibilities to the individuals and team. For instance, a specific project team is responsible for consultation with the community and gather the required information for mapping their project. In addition, it also visualizes the initial work breakdown structure of the project. The other project teams focus on the infrastructure, data analysis and utilization of tools involved. Moreover, visual management incorporated with the mind mapping tools enables the project team for adaptability and allows to accumulate, manage and develop effortless necessary communication medium throughout the project. However, prior to the project activities, manager emphasizes to utilize this visual tool to develop conceptual ideas and set strategic goals among the team members. Additionally, proper mind mapping facilitates the team in undertaking feasible planning that can ensure the quality and successful execution of the project. In the project, the contribution of mind mapping can be seen in several areas:

Table 13: Mind mapping in Sydney Metro West project

<b>Area of Utilization</b>	<b>Working Procedure</b>
Project Scheduling	Project team integrate mind mapping with project scheduling to exhibits project Gantt chart and process diagram
Project Budget	Team avail their approximate budget of the project establishing a link between mind mapping and excel spreadsheet
Project Risks	Provide the list of risks and notify it in the visual dashboard so that the employees in the construction site and management always keep in mind about the precautions and safety

Communication	Team members maintain their communication with the excellent representation of information. Moreover, the external members of the project also can get access to the project information through websites and online reports
Planning	Project managers establish their planning based on the systematical organization of project activities and make it visible and accessible to all the members and stakeholders
Monitoring and Controlling	Support the management team exhibiting the key information regarding the project in the dashboard and allows to make feasible monitoring and controlling decisions

#### 4.2.4 Application of visual management

In Sydney Metro West project, manager and the team emphasizes on standardization of their project activities that accelerate the project implementation and control phase promptly. Moreover, the continuous improvement process and fostering innovative approach motivates the high-level stakeholders to invest more in the project. The application of visual management in the Sydney Metro West project is significant and the benefits of utilization of this approach are already experienced before in other metro projects (Visual amenity mangement report, 2017). This construction project follows some lean methods and as a part of lean techniques, visual management provides convenience for managing the activities and support quality project delivery. Similarly, utilization of visual elements in Sydney Metro West case play a significant role in eliminating information deficiencies, reduce unnecessary human activities, for instance, asking, guessing, quality control, searching, etc. For synchronizing the project tasks,

comparing the project status with the planned task versus actual task project team prefers to utilize visual management to get actual outcomes.

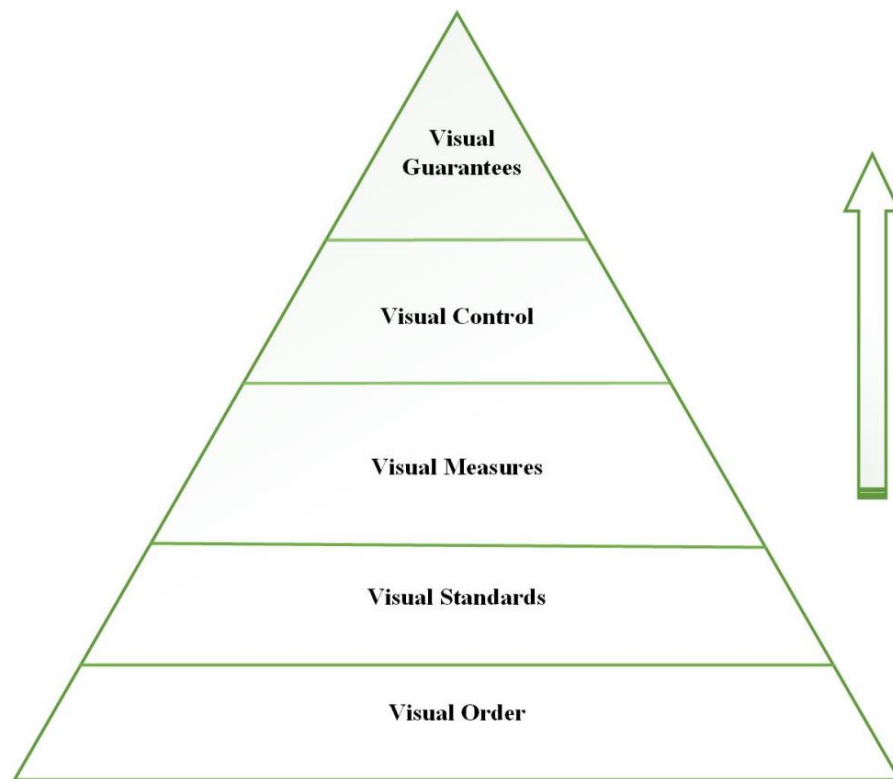


Figure 23: Galsworth's (2005) VM application framework (Characteristics for Sydney Metro West)

The framework of Galsworth (2005), allows analyzing elements of visual management in the project practices of Sydney Metro West. Comparing the context of the project, each tier of the framework can be described as below:

- The bottom tier of the framework, visual order stand for systematically organizing the project management process and activities in Sydney Metro West. The activities regarding project management plan strongly connect with each other. Prior to the project launch or implementation phase the project team systematically collocate all the preceding activities, for instance, planning, procurement, safety, servicing, stakeholders engagement, etc. Project scheduling and mind mapping techniques support to visualize the steps regarding the project and based on the priority of activities project management team established systematical procedural steps. Associated with the visual management tools,

moreover, visual order accommodates the project team and the departments involved with the project understand their upcoming events and are aware of maintaining the project smoothly. Moreover, through visually ordering the processes, it allows proper planning of the project by considering the previous track records and systematic utilization of equipment, tools, materials, machines, and resources which lead towards effective project outcomes.

- The next level visual standard indicates the standard communication methods, procedures, practices among the project team, departments and key stakeholders. Within the project, the team conducts a monthly and yearly review of their project status. Being a complex construction project, in Sydney Metro West, the visual standard supports the project management processes through establishing standard communication and procedures. Before launching the project, the planning process refines a couple of time depending on the changing requirements. Publishing the project status and updates on the website allows the community and NSW government to send their feedback. Based on the feedback team arrange meetings and gather the best possible suggestion and manager is bound to answer the questions asked in the meeting. On the basis of outcomes form the discussion the project plan and activities are updated and members of the project team are notified via visual tool and techniques. Delivering the proper and time valuable information through the visual standards maximize the input at the early stage of the project as well as influence the shape of the project development.
- The visual measure establishes a transparent project environment and measures the performance of the project. The current stage of the project and construction progress is visible in the project dashboard. Moreover, the project controller maintains all the updates and make it visual by utilizing visualization methods. Similarly, through the website, the status of the project is explicitly visible and accessible to all. Compared with the other metro rail projects visual measure facilitates to identify the variations and that helps to evaluate the drawback of the project. The way of measuring performance is not revealed in the project report, but, the visual measure provides support to measure the project performance. As visual tools (e.g., Microsoft Project ) record the previous data of another metro project, so it effortlessly compares the performance of the project.



- In an enormous project like Sydney Metro West, practical decision making to control the project relies on multiple factors. Report of Sydney Metro West project does not show strong evidence that their project decision making relies on visual control output. Visually displayed project status assist the manager to make some quick decisions like procurement of tools, machines, managing the risks, etc. However, in case of serious issues, like environmental impact, changing the route, change of planning, accept the requirements for government and key stakeholders and so on, managers can not afford to rely on the visual control solely. Even though visual control allows to identify the potential threats, analyze the probable solutions, but in terms of complex project context, the manager is required to consider all the aspects before taking key decision making steps.
- Visual tools are most preferred to be utilized in the project construction site to ensure the actual and precise implementation process. Different visual signs, signals, indicator ensure the safe and secure implementation process. Utilizing the lean methods like kanban, visual board; allow the employees in the construction site to remain updated about their daily tasks as well as become aware of their upcoming activities. As a result, the team always focuses on its tasks and is concerned about the timeline. The project management team is always aware of the fact that implementation of progress depends on the visual board on site. However, visual management cannot stand alone to support this mistake-proof construction site. Incorporated visual tools and other lean methods provide a robust and composed project execution environment.

However, the overall characteristics of visual management elements towards project success are summarized below:

Table 14: Summary of visual elements characteristics in Sydney Metro West project

VM elements	Role in Project

Visual Order	Systematically organizes pre-execution project activities. Support the planning phase to estimate the date of project completion
Visual Standards	Established standard visual communication, procedures throughout the project activities. Maintain the proper flow of information
Visual Measures	Ensure transparency of the information and visualize to all who involve in project activities. Compare the variations of the project with the recorded one. Performance of the project not entirely rely on this visual performance measurement.
Visual Control	Decision making and control consider all the factors regarding the project. Visual control supports a few decision-making processes.
Visual Guarantees	Used in construction to control and support on-site employee through visualizing regular tasks, targets and goals. Depend on lean methods to perform.

Based on the above characteristics the level of significance of visual elements in Sydney MetroWest project can be summarized in the below table:15. The elements which have a higher role in project scored as “3”, moderate scored as “2,” and lower role is scored as “1”.

Table 15: Level of significance of VM elements in Sydney Metro West project

Visual Management Elements	Level of Significance in Project (Score)
Visual Order	3
Visual Standards	3

Visual Guarantees	2
Visual Measures	2
Visual Controls	1

#### **4.2.5 Visual and PM relationship in controlling project**

The Sydney Metro West project team focuses on achieving the project goals with efficient project control processes. Relying on the characteristics of the project, the team, however, concern about project sustainability simultaneously focus on project goal when the project is progressing. The massive infrastructure based complex project generally collaborates with different levels of stakeholders, public sectors, project departments and involves engagement of foreign and local industry. Project manager and the top management always monitor the project activities as this project is entire of public concern. Involvement of huge mechanisms, machines, and tools may make the implementation phase bit stressful for the project surrounding, social community, and the environment. In addition, sometimes there is a possibility of risks like accidents to the operational forces. However, ensuring the safety, updating the project information, implementing the critical decisions, maintaining the project steps and consumption of resources, etc are controlled by the efficient project management team that is busy in the successful project deliveries. In terms of controlling the project, the team emphasizes the following factors:

- Project planning
- Engineering and competency
- Stakeholders and community
- Safety assurance
- Resource management
- Project budget
- Construction and quality

Integrating the visual management with the project management activities allows this metro project team to control and monitor the entire project life cycle. Lack of project control sometimes raise uncertainties and potential risks within the project. Reports of

Sydney Metro West project contains some evidence about the absence of robust control process in previous metro projects. Additionally, all the project management steps in this Metro West cases are connected with each other and one step influences other stages unintentionally. The important overall project activities for instance planning, budgeting, allocation of adequate resources, scheduling, performance measurement can be integrated and monitored through different visual management activities. The framework of J. Kivilä et al. (2017) illustrates the anticipation of visual management with key project activities that lead towards the goals and successful deliverable of the project.

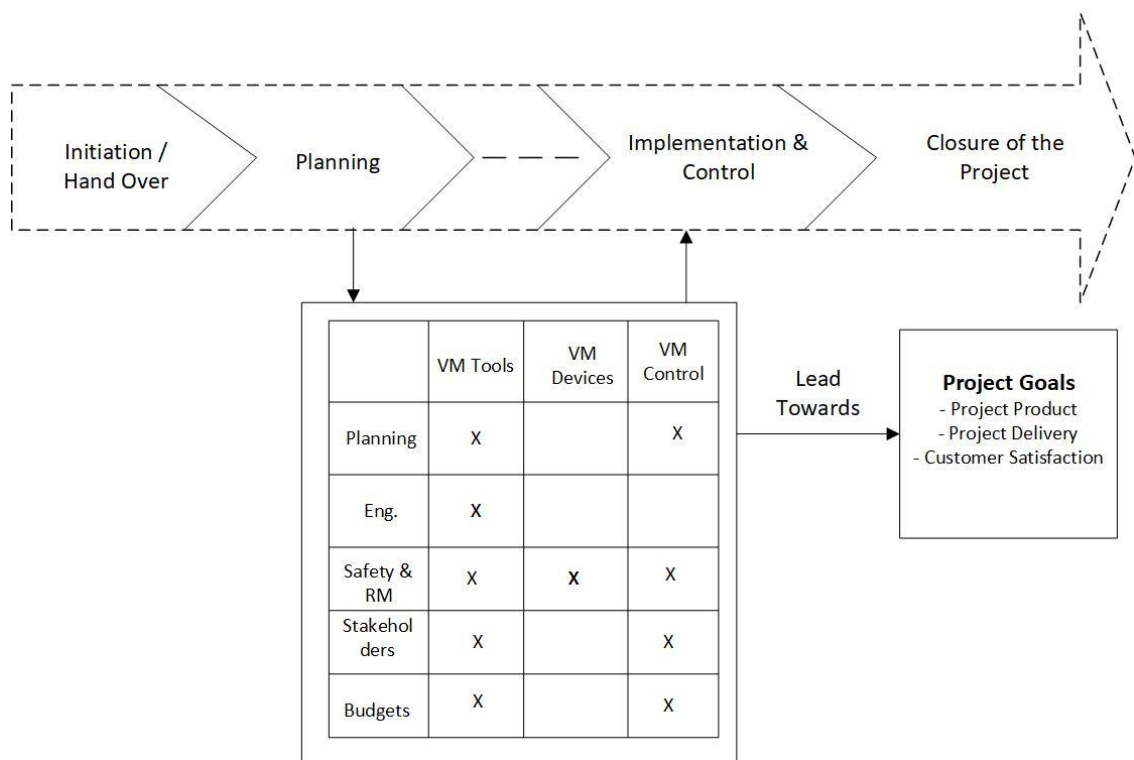


Figure 24: VM in different activities of PM to control project (for Sydney Metro West)

The framework demonstrates the relationship between different visual management actions in Sydney Metro West project management activities. Like other metro rail project, Sydney Metro West project initiated with the planning phase after systematical orientation of preceding steps of the project. Depending on the consultation outcomes; the characteristics of project locations, government support, and other external and internal factors, planning is made along with the project scheduling and mind mapping tools are used that promote effortless decision making for managers. In addition, the utilization of visual tools, for instance, mind mapping facilitates in breaking down the engineering requirements like making a list of engineering equipment, machines, tools,

materials for excavating the tunnels and set up railways. Safety and risk management is one of the key issues throughout the project progress. Any uncertain hazardous condition will cause the project delay. For mitigating the risk and ensuring the safety precautions the project team tend to utilize all the visual management actions. Moreover, on the construction site, different devices like visual signal, signs, and indicator guide the employees and workers to follow the safety rules. Visual control promotes the managers to analyze the feedback from the visual devices and take necessary precaution in the worksite. Managing and communicating with external and internal stakeholders like suppliers, transportation for NSW, the involvement of local and foreign industries brings awareness of the project and future market opportunities. The responsible project team members keep the stakeholder updated about the project status through visual measures. Even though the contribution of visual control is not seen much in stakeholder's management perspective but a few cases, it is taken into account. However, proper mapping of processes and decisions form the managers allows the proper utilization of the allocated budget. The NSW government refines the budget based on the project report and consultation with the community and for that reason managers are enforced to reschedule the project plan. Visual tools and control anticipate the changes and eliminate unnecessary delay in project execution phase that may overrun the allocated budget in Sydney Metro West project.

Analyzing the above characteristics of the project, the functions of visual management is summarized in the table below:

Table 16: Functions of visual management practices in Sydney Metro West project

Functions of VM	Project Practices	Actual Outcomes
Transparency	Explicitly visualize the flow of information from beginning to the end of the project through website and form of reports	Track down the project status, support decision making, analysis and project progress.
Discipline	Systematically organize the project pre-execution	Facilitate to established standard procedural steps

	activities associated with for smooth project scheduling and management lifecycle. mind mapping tools.	
Continuous improvement	Improvement is done through feedback from the different level of the project, for instance, strategic planning or investment, support to redefine project goals and improve quality	Maximize the project outcomes, eliminate the unwanted tasks and assist in improving the project performance
Job facilitation	Ease of employees' task providing the notification about the upcoming events and support to make a plan to handle the tasks. Not thoroughly utilized all the levels of PM	A better understanding of employees responsibilities in a complex environment
On-the-job training	This functions is missing in Sydney Metro Case but in previous metro rail project facilitate this function within their project	As not facilitate in the project, as a result, no significant outcomes are shown
Creating shared ownership	Ensuring the proper transfer of information through websites and weekly reports create a positive impression on stakeholders to sharing their ownership in the	Motivate the high-level stakeholders for investment and maintain a strong relationship

project		
Management-by-facts	Typically missing in the project as the hierarchical levels are long and facts are hard to visualize to the top level management	Bit challenging to maintain and control the undesirable facts like misuse of power, internal politics etc.
Simplification	Simplify the complex and dynamic environment and response quickly in case of sudden changes like government influence to changing the route, environmental factors	Reduce the time of decision making and establish strategic planning capacity
Unification	As the hierarchical levels are complicated and required to change based on project requirements, so synchronization of the layers is not guided through this function of VM	No significance outcomes are observed in this function

### 4.3 Cross-case analysis

The cross-case analysis is an impactful way of representing the similarities, themes, and differences in the research where multiple case studies are involved. The core visual management processes and the contribution of their practices in the two case studies are compared in the following table 17:

Table 17: Cross-case analysis

Characteristics	ANDRITZ Oy	Sydney Metro West
<b>Project Content</b>	Manufacturing, supplying and installing the equipment	Construction
<b>Project Complexity</b>	Complicated	Complicated
<b>VM in Project</b>	Not thoroughly utilize in all the project management activities. Provide support to the management and team associated with some cause identification tool and participation of elements within the project	Transfer the flow of information beyond the project management stages. Visual tools support to exhibits the initial project mapping and elements are utilized based on project characteristics
<b>VM Outcomes</b>	Project Scheduling, identifying the root cause of the problem, improve quality, enhance communication with the team, help to find potential cost overruns and delays	Ensure transparency in project information. Improve communication with the project team, key stakeholders and community. Support managers' with critical decision-making steps. Identifying potential threats and delays. Proper



		resource allocation, cost, and budget control.
<b>Area of utilization</b>	Typically utilize internally in the project management department. Suppliers and customers notified about the project status in the form of a report.	Both internal management and external members of the project experience the benefits of visual management. The Stakeholders and key members of the project, workers in the construction site get notified the status and future activities of the project.

ANDRITZ Oy and Sydney Metro West have two different sorts of project management processes. ANDRITZ Oy supply and install different equipment for pulp and paper industry and energy plant as well. On the other hand, Sydney Metro West is a vast construction rail project under the Sydney Metro extension plan.

Projects of ANDRITZ Oy are typically complicated in nature. In some big projects, the major part of their engineering activities are done in India office and at the same time, some portion of engineering is done by local suppliers and engineering companies. However, all the initial activities run simultaneously within and outside of Finland which creates more complexity in project management processes. On the other hand, the estimated budget of Sydney Metro West project is USD 3 billion in 2018-2019. The enormous project is largely built in underground and involvement of experienced 400 employees, 8,000 workers. Moreover, combining all the stakeholders, local community, local and international industrial engagement, and diverse project activities, procurement and project management team directed the project to open in the second half of the 2020s. Both the projects, therefore, have different project characteristics and complexities.

Managers and management of ANDRITZ, usually endure the benefits of visual management through cause identification tools and utilization of some visual elements. The tools mitigate the hypothesis activities regarding solving the issues and enhancing the quality of the process. The project management team tries to find out problems in all levels of the project implementation phase, specially in case of delay of the project. However, ANDRITZs visual management practices do not cover all the levels of project management activities due to their long lists of supplier and involvement of international branch. Most of the suppliers and customers receive information in the formal corporate procedure. However, visual management is confined within the ANDRITZs internal project practices but not in a broader organizational perspective. In Sydney Metro West project, it supports the project management department for creating initial project mapping to exhibits the complete project overview. Moreover, it allows the managers to propose the estimated plan, work breakdown structure and set standard activities for the project. Besides, visual management ensures the transparency of project status for not only the members involving within the project but also members outside the project. Being a construction project, the elements are utilized not entirely but according to the characteristics of the project.

In both case studies, significant outcomes were observed. Visual tools and elements provide support to develop proper scheduling of project plan and systematically organizing activities for ANDRITZ. Besides, root-cause analysis facilitates to figure out the problems in case of delay in the project and expose the reason behind it through the diagram. However, even though visual management maintains communication among the members, assist in identifying potential cost overrun and few significant roles, but still, countable outcomes are observed due to the limited area of application throughout the project. Sydney Metro West project, emphasizes to complete their project within the allocated budget and proper cost controlling process. Visual management facilitates in controlling the resource allocation and effective utilization of machines, tools, identification of potential threats and implementing the solution. Because of the involvement of a vast amount of complex activities, the decision making of project managers does not entirely depend on visual management. In terms of any instant decision-making situation, managers allow involving visual management to support their decision-making process.

Visual management is typically utilized internally in ANDRITZ's project management practices. It facilitates the exhibition of status and performance of the project in the form of a report to the upper management and project manager. It not only shows the current status of the project but also explicates the actual trend whether the project is lag behind or ahead of the planned trend. In Sydney Metro West project, visual management ensures the transparency and proper flow of information from the local community to high-level stakeholders and the chief executive of the project as well. ANDRITZ's project management processes mostly rely on customer requirements and suppliers feedback. As a result, the area of utilizing visual management practices is limited in some cases. In contrast, Sydney Metro West is a vast construction project that enables the manager to implement VM widely throughout the project. In both cases, visual elements and tools allow reacting promptly before the more significant threat arise and help in precise decision-making opportunity. The hierarchical level of the project also influences the proper implementation of visual management.

The difference in project management characteristics is the primary reason behind the comparison of visual management practices in two case companies. Moreover, a separate area of utilization, for instance, ANDRITZ prefer to utilize visual management internally, shows different outcomes of visual management practices, also a potential reason to create the distinction. The level of complexity also restricts the involvement of visual practices within the project. Since ANDRITZ is installing different types of equipment in the power plant, so their complexity and characteristics vary depending on the number of stakeholder's involvement, project budget, duration of implementation and size of the project team. On the other hand, in Sydney Metro West the level of complexity and characteristics barely varies, and the activities and resources behind the project are predetermined and planned before the start of the project. Therefore, analyzing the two case contexts, it is seen that visual management is capable of synchronizing any project management area, yet the purpose should be understandable to everyone beforehand.

## 5. DISCUSSION

In advanced project management practices, visual project management is considered a vital part of leveraging an effective and efficient project controlling outcomes. The practical case analysis in this research helps to demonstrate the findings and the positive outcomes of visual project management in two different types of projects.

Visual management combines the project management systems, elements of workplace, processes, and stakeholders. In this research, both cases studies exploit the contribution of visual management in their project management processes. By analyzing the research, it was identified that to avail the best possible outcomes from visual management; it should be utilized both externally and internally within the project. However, the empirical analysis stated that in ANDRITZ, visual management was mostly used in all the project management stages to monitor the progress of the project and reporting. It is entirely utilized for supporting the project management department and not for broader organization perspective. Therefore, the top management has notified about the project status in the form of a report and those reports are submitted in a weekly or monthly basis. As a result, top management has deprived of day to day update of their key projects. Visual management ensures transparency and smooth flow of information among the project team and manager, although decisive suppliers and customers do not have access to integrate with the visual management system. Typical corporate communication methods are still followed to notify the key stakeholders of the project. Maintaining a strong understanding within the project team, moreover, visual management facilitates to closely monitor the project and reduce the response time of managers. However, the business performance of ANDRITZ is driven through the improvement of the efficiency which can be achieved by connecting the project team and stakeholder through the visual practices. In Sydney Metro West project, multiple complex activities and strong monitoring of the project, demand to utilize the visual management within the project. Informing the project progress, upcoming events, generating the project report and establish reliable communication with the key stakeholders through visual management which is focused on supporting the management as well as establish a continuous improvement process. Visual management allows the project team to unleash their project report to not only the members involving with the projects but also the community of the Sydney western region via the website. This facilitates to get feedback and find out a

feasible way for improvement of the project. Sydney Metro West experiences the actual outcome of using projection mapping and information. As a part of lean tools, the practices in two case studies indicates the role of visual management in maintaining communication within team (Bhasin, 2008; Hodge et al., 2011) for ANDRITZ, and improve workplace organization (Bhasin and Burcher, 2006) and continuous improvement (Hodge et al., 2011) facilities for Sydney Metro West project.

Visual management supports decision-making activities based on project feedback in a specific context. The complexity of Sydney Metro West project is relatively high, as its enormous transportation project involves multiple project management stages and tasks. Visual management promotes effective decision making of Sydney Metro west project in some specific situation. In a construction project, usually multiple project tasks, stages and a large number of stakeholders are involved. So, in case of any decision making, project managers barely rely on visual management outcomes. They prefer to consider some real-time feedback from the project site and arrange inter-departmental meetings. However, some evidence shows that in some cases, for instance, sudden quick decisions in lower priority context, the manager considers the outcomes form visual management tools and the elements. The project managers of ANDRITZ always focus on outcomes of visual management for effective decision making. Whenever, the implementation, manufacturing, procurement and other activities are done inside Finland then manager and team can take their decision based on visual outputs. Project dashboard is always updated depending on the project progress and allows to take prompt decisions. Explicit and smooth transfer of project information among the project team members often decreases the time required to get one point in terms of decision making. Besides, by recording the previous history of other projects, the variations can readily be distinguished that promote to analysis the reason behind the distinctions. In this research, the evaluation of project performance through visual management is not found yet, even though the literature of Hyland and Beckett (2002) suggest the project performance evaluation through visual management delivers a competitive advantage for the project. However, in reality, both case studies did not show any evidence of project evaluation techniques associated with visual management.

Visual project management practices allowed ANDRITZ and Sydney Metro West to actively manage the project through the utilization of visual elements and tools. With a

lack of evidence about the visual tools, the discussion about further tools is not possible. Essential visual tools, for instance, root cause analysis and mind mapping help to identify the problem and to monitor the project activities correspondingly. Following key visual elements like visual order, visual standard and visual devices ensure the progression of the projects that lead towards the project successes. Combination of visual tools and elements enables the project manager to control their project. Previous literature, emphasizes the term "project control" to achieve actual project outputs. Most of the scholars prefer to utilize the visual tools and elements depending on the project characteristics (Liu et al., 2014; Nieminen and Lehtonen, 2008). The two case studies also complement the scholar's opinion as the managers prefer to allow the participation of visual tools and elements based on project characteristics. All the visual management elements and tools that are utilized in the project management practices of ANDRITZ and Sydney Metro West results in control of the project characteristics. Project scheduling, planning, budget, cost analysis, resource allocation, performance measurement, workplace control, and overall project status report are controlled, generated and monitored by systematic implementation of visual project management practices. However, the framework of J. Kivilä et al. (2007) demonstrated the relation of visual management that integrated with the project management activities in the case project. In this research, both of the case companies cover the two different project areas. As a result, they have different project management practices and steps. Through the interview and analyzing the reports and materials, it is identified that the visual management process is an effective way that is directly related to the increase in guidance and control of the project. Moreover, project improvement and control significantly rely on team performance, productivity, execution of planning, monitoring the project progresses and the visual environment. Nevertheless, the quality, consistency, and efficiency of the project and in parallel, satisfying the stakeholder's requirement is also targeted through controlling the project (Abidin and Pasquire, 2007; Fernández-Sánchez and Rodríguez-López, 2010).

In this research, the participation of visual activities face some challenges in both case studies. Visual management can find the potential risks or threats within the projects. However, in terms of more significant issues, visual management is unable to support problem-solving techniques as it is not utilized entirely in all project management activities. So, in that case, managers need to take support from the risk management

department. The most exciting fact is that visual management provides backings for risk managers in both case studies. Due to technological improvements, the tools are improved and updated so that they could be synchronized at any project practices. Lack of adaptability of traditional project management practices hinders the involvement of modern tools in an existing project. However, in ANDRITZ, the project report is generated based on visual outcomes. Therefore, before generating the report the team is required to crosscheck the visual management outcomes with the actual scenarios. Quick changes of customers' requirements sometimes lately appear in the visual dashboard and in that case, some traditional methods are forced to be utilized in ANDRITZ. Following the previous experience of other metro rail project, Sydney Metro West focuses on stakeholder and community consultation with the project team and simultaneously emphasize the safety issues on the worksite. Relying on the consultation outcomes, characteristics of project locations and other external and internal factors, planning is made associated with the visual tools and control systems. As most of the researchers consider the internal project control process (Cardinal et al., 2010) but in the extensive construction, supplying, and installation projects have represented obvious relation to the external project control system. Nevertheless, this research suggested that visual management provides the project competence, maximizing the outcomes and conversely, a lack of visual controls inhibited the improvement of project performance and efficiency.

The first research question focused on the impacts of visual project management practices in the various project management processes. Typically, due to the increasing complexity, maintaining the budget, time compressed nature of the projects, the tracking and focus on the milestones and prepare the deliverable accurately becomes more challenging and difficult nowadays. Visual project management compiles all the required project information and feedback about performance and status, decision-making processes under the one umbrella. Incorporated with the lean techniques the contribution of visual project management focused on the improvement of the project outcomes, reducing the response time and eliminate waste in each project management stages. Relying on the project management practices like construction or manufacturing visual project management improve communication among the project team members, stakeholders, project scheduling, control the allocated budget, resource allocation, cost estimation, identify the potential threats and providing problem-solving methods to the responsible project management. Moreover, visual project management optimize the rework, ensure

accountability of team members and their actions, establish the basis for empowerment and ownership and most importantly create a transparent project management environment that leads toward maturity of the project with the estimated scheduled time. This study reveals actual outcomes of visual project management in two different project practices. Improving project performance and way of controlling the project in modern infrastructure project and identify the role of different visual elements in every project management stages. Therefore, the functions of visual management validate its contribution to different project practices. (Section 2.1.1).

The second research question is concerned with the utilization of visual elements and tools that enhance in the context of the project. Various visual elements and tools are used in different stages of the project. Those tools and elements have a different role that executes relying on the specific expected outcome. In this research, the framework of Galsworth (2005) describes the role of visual elements to constitute a composed visual project management environment. Utilizing the framework, the specific visual practices of both the case studies were validated (2.1.3, 4.1.4, 4.2.4). Besides, throughout the project, the participation of visual project management tools (Section 2.2) set a standard dialect for discussions and talks among the individuals within and outside of the project. Proper implementation and utilization of visual project management tools and elements leverage the improvement of project efficiency and standardize the project activities.



## 6. CONCLUSION

The primary goal of this research was to provide an understanding of the visual project management practices profoundly in different projects, which facilitates the improvement of project efficiency by eliminating non-value-added activities through providing the predetermined information of project status, data-rich environment for better decision-making, real-time issue management, and resolution status. Different organization and construction projects have different project management characteristics. In this research, the empirical studies were carried out in two different project management case companies where the roles of visual elements, tools, and contribution of the controlling project were analyzed through qualitative feedback method. Through the extensive literature analysis on visual project management, its functions, tools, elements and the current state overall research was carried out. Moreover, the real case studies through semi-structured interview and analyzing the reports and materials shows the evidence of attributes of visual project management practices.

The previous scholars noticed that over the last few decades conveying the information over the long distances has tremendously improved, thanks to fast developing technologies for contributing to solving this problem. So, recently most of the project personnel can deliver their essential information to their workforces within close range of communication (Bilalis et al., 2002). Realizing the necessity of visual management from Toyota Production System this concept has now added core value to all project management practices. Visual management usually connects other management systems, workplace elements, work processes, and stakeholders, by means of anticipation (Liff and Posey, 2004). Eliminating the nonvalue-added activities, controlling the projects, identifying the potential threats and ease of decision-making are all the advantages that leverage the visual project management practices as a crucial part of project management. However, the success of the project ultimately rely on these factors and any interruption can hamper the project process. Moreover, it sorts out the potential threats and risk that might affect the project and visual practices enable to make precautions to tackle them. In order to have effective and efficient project control techniques, both the internal and external factors should be controlled through visual management (Liu et al., 2014). Nevertheless, the overall success of the project should not depend on how visual management is utilized. As a part of lean tools, primary aspects of visual management is

to ensure a well oriented and organized environment and create indulgence to the project manager to control the project. Additionally, prior to implementing visual management, the project team should evaluate and understand the purpose of the visual practices on a broader scale. As a result, an effective and efficient visual project management strategy, along with implementation methods can be established that helps the organization to gain their success in their project and accomplish the project with maximization of profitability.

## **6.1 Managerial implications**

The findings of this research are evaluated for excellent practical use and undoubtedly, there are various practical implications for the project managers in the organizations. Typically, project managers focus on finding the strategies that can deal with the uncertainties and ambiguity within the project activities. Moreover, accessible, transparent information about project activities facilitate the effortless decision making for the team members and managers. However, communication within the team is a crucial part of the project success that allows avoiding multiple and undesirable conflicting interpretations of the situations. In addition, coordinating and understanding multiple stakeholder's viewpoints, managers always require to understanding those viewpoints to establish sustainable project management practices. As visual project management creates a common base for communication; as a result, it creates awareness for the managers and delivers the key messages regarding the project status. Visual project management empowers the managers to control the project within its boundary. This research indicates that proper utilization of visual management practices allow the managers to actively maintain control of the project as it delivers all the required information of the project in a single point. It identifies the potential threats that hamper the project progresses and as a result, managers promote the prevention steps and precautions to avoid and solve those unexpected issues. It not only shows the status of the project but also supports the managers by providing the actual trend of the project so that management can notify the progression percentage of the project compared to the planned. Removing the information deficiencies, moreover, visual tools and techniques also allow the project team to react quickly at an early stage before the problem is getting bigger. Nevertheless, by establishing hierarchical discipline within the project, visual

project management ensures accountability of the team members, improve the project performance and directs the project towards its goal.

## **6.2 Limitations and further research scope**

Like other researches, this research also has some limitations. The research was performed in a qualitative manner where an interview was conducted. The data recorded in the interview was interpreted which may have a chance of biasedness or misinterpretation. Moreover, the interview was taken from the project manager of the case company, so reaction and understanding of visual practices from project team members remained unrevealed. The research was conducted on only two projects and one of the project data was collected through some reports and public documents. Even though most of the information in documents was explicit but gathering information from an experienced person will help to understand more about the real-time visual practices within the project. Moreover, due to confidential issues, the interviewee unwilling to unleash much crucial information about their practices. However, the empirical analysis was based on construction and organization project process, whereas other studies in different types of complex projects may give some other additional perspective.

Nevertheless, more case analysis may allow drilling down the empirical study profoundly. Hence, considering other areas of study, for instance, technological or product development may deliver other perspective and more issues regarding the study. Further research could map the use of visual project management practices for project sustainability and investigate its drawbacks. Establishing the standard visual project management evaluation tools for the complex construction project will be another future research scope.

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## APPENDIX

### Appendix 1

#### Interview Questions for ANDRITZ Oy

1. How visual management currently support your project management process?
2. How your organization adopts a visual management system to plan and control the project management process?
3. How do you experience and understand the visual project management practices in the manufacturing related projects?
4. What are the visual project management tools that support your managerial efforts?
5. How your employees and workers anticipated with the visual management practices within their project management process?
6. Visual project management has the ability to identify the problems and suggest a way to solving the problem- do you agree with this statement. Could you please describe some real time problem in your projects that you have been identified through visual management tools?
7. How the inclusion of visual management improve your project management process effectively?
8. Does visual management influence in reducing process wastes, project costs, quality problems and safety issues at the different level of the projects?
9. What are the potential threats that can be identified utilizing the visual management system in your ongoing or previous projects?
10. What are the attributes of visual management to solve or mitigate the potential threats or severe hiccups during the project?
11. How do you utilize the visual management system in terms of complex situations of projects? Do you find any benefits out of it or face some challenges? How does it help in decision-making?
12. What kind of traditional approach that has been replaced by the visual management system in your typical project management practices?
13. What are the roles of visual practices to enhance the overall project performance?

14. How the utilization of visual guides influence the improvement of project environment efficiency?
15. Can your worker have the ability to take his own decision in adverse condition?  
Do visual practices empower their communication capability with others as well as top management?
16. How visual management practices support the decision-making for project managers within a shorter period of time or in a critical situation?
17. How visual management compatible and control your high volume production projects?
18. How many responsible persons are there to monitor the visual performance and organize the training, briefing or introduction of new tools and techniques in your organization?
19. How project managers get benefits and keen to implement the visual project management practices in a wider range of project management of your organization?
20. What is your expectations or areas of improvement of visual project management that could serve the stakeholders as well as ease of employees and management activities within the projects?
21. How do you evaluate the contribution of visual project management practices in modern project management philosophies in large-sized companies (LSC) like yours?